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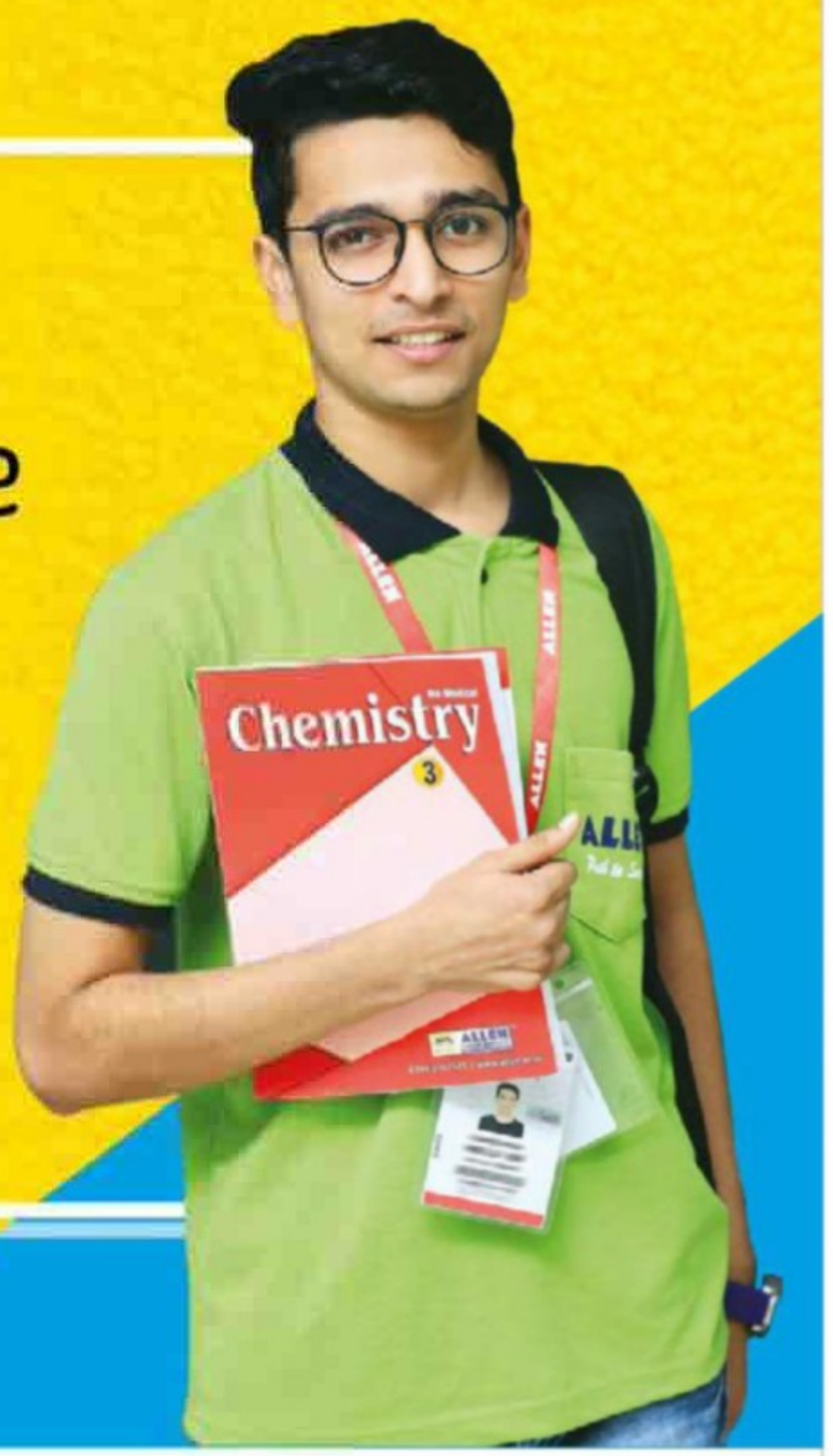

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SUNDAY OPEN

CHEMISTRY today

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Editor : Anil Ahlawat

GET SET GO for JEE

with exclusive and brain storming MCQs

Practicing these MCQs help to strengthen your concepts and give you extra edge in your JEE preparation

Only One Option Correct Type

1. One mole homo triatomic gas effuses $\frac{4}{3}$ times faster than 1 mole CH_4 under similar conditions. Select the incorrect option about homo triatomic gas.

(a) Atomic weight = 18

(b) $d_{1\text{ atm }\&\ 273\text{ K}} = 0.4017$ g/L

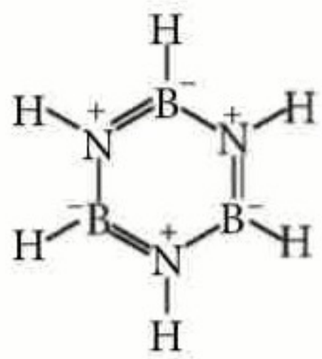
(c) Vapour density of gas = 4.5

(d) None of these

2. $BCl_{3(\text{excess})} \xrightarrow[\text{ether}]{LiAlH_4} (A) \xrightarrow[\text{(ii) High temperature}]{\text{(i) Excess of } NH_3} (B)_{(\text{liquid})}$,

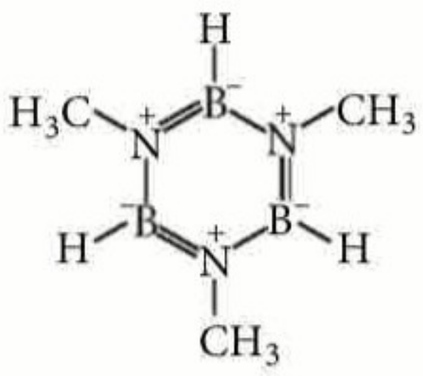
(B) is

(a) Borazole,

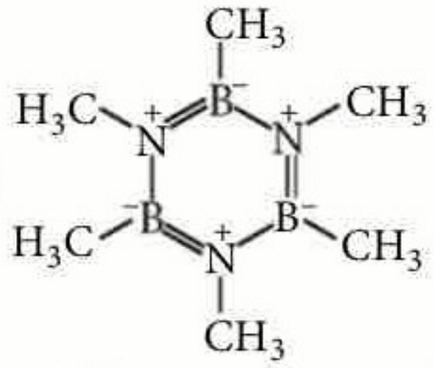


(b) Boron nitride, $(BN)_x$

(c)



(d)



3. In a hydrogen spectrum if electron moves from 6^{th} to 2^{nd} orbit by transition in multisteps then the number of lines in spectrum would be

(a) 6 (b) 8

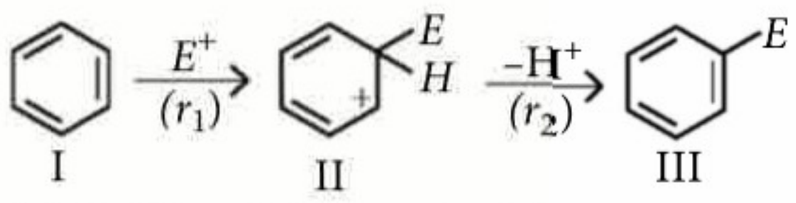
(c) 10 (d) 9

4. Solubility of $CaCl_2$ is 4×10^{-8}, then what would be its new solubility in the presence of 10^{-2} M $Ca(OH)_2$?

(a) 6×10^{-11} mol L^{-1} (b) 8×10^{-8} mol L^{-1}

(c) 8×10^{-11} mol L^{-1} (d) 9×10^{-8} mol L^{-1}

5. Which statement is true for the following sequence of reactions?



(a) C_6H_6 and C_6D_6 react with almost same rate for most of the electrophiles.

(b) II is an aromatic species.

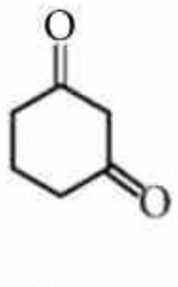
(c) Rate of first step (r_1) is faster than rate of second step (r_2) in most of aromatic electrophilic substitution reactions.
(d) Electrophilic addition is more favoured than electrophilic substitution in benzene.

6. Select the correct statement.
(a) Blue solution of Na in liq. NH_3 is unstable with respect to amide formation.
(b) Na_2O_2 reacts with CO and evolve O_2.
(c) Li^+ does not form alum due to its high hydration energy.
(d) $NaNO_3$ when heated at 800°C produces two gases, both are paramagnetic.

7. Given below are the structures of five organic compounds (1) to (5) which can tautomerise.

$PhCOCH_2COCH_3$, $PhCOCH_2CH_3$,

(1) (2)

$PhCOCH_2COOC_2H_5$,  , 

(3) (4) (5)

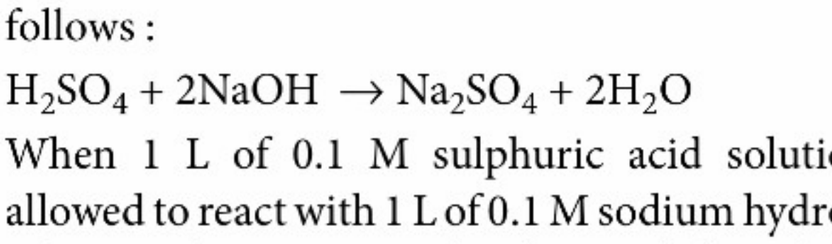
Select from the following the incorrect statement regarding the enolization of the above mentioned compounds.
(a) (5) is extensively enolized compared to (4).
(b) (4) is extensively enolized compared to (5).
(c) (1) is extensively enolized compared to (2).
(d) enol content of (3) is more than that of (2).

8. Sulphuric acid reacts with sodium hydroxide as follows :

$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$

When 1 L of 0.1 M sulphuric acid solution is allowed to react with 1 L of 0.1 M sodium hydroxide solution, the amount of sodium sulphate formed and its molarity in the solution obtained is
(a) 7.10 g and 0.1 mol L^{-1}
(b) 7.10 g and 0.025 mol L^{-1}
(c) 5.40 g and 0.1 mol L^{-1}
(d) 3.55 g and 0.025 mol L^{-1}

9. Using Huckel's rule predict, how many of the following are aromatic compounds?



(a) 6 (b) 5
(c) 7 (d) 8

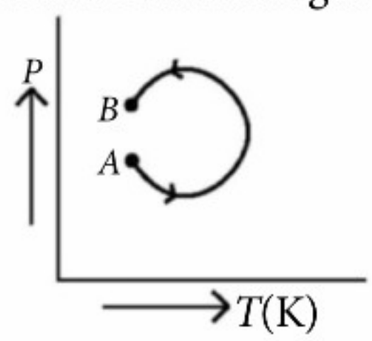
10. Which of the following statements is correct for the given reaction?

$H_2O_2 + KMnO_4 + H_2SO_4 \rightarrow MnSO_4 + H_2O + O_2 + K_2SO_4$

(a) Number of g equivalent of H_2O_2 and $KMnO_4$ reacts in the ratio of 5 : 2.
(b) Number of moles of $MnSO_4$ and O_2 produced in the ratio of 5 : 2.
(c) Equivalent mass of H_2SO_4 is 29.4.
(d) H_2O_2 shows oxidising character and the pink colour of $KMnO_4$ solution is discharged.

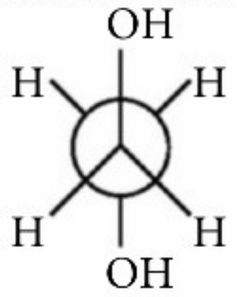
More Than One Options Correct Type

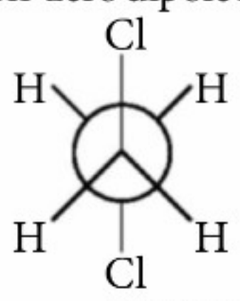
11. With reference to the given graph, choose the incorrect option(s) for fixed amount of an ideal gas in going from *A* to *B*.

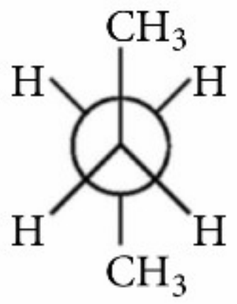


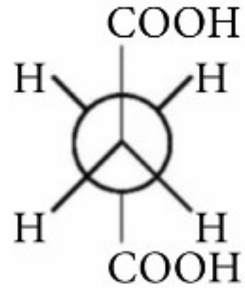
(a) $V_A > V_B$
(b) $P_A > P_B$
(c) $V_B > V_A$
(d) $T_A = T_B$

12. Which conformation/s have non-zero dipole moment?

(a) 

(b) 

(c) 

(d) 

13. Which of the following groups of molecules do not act both as oxidising agent as well as reducing agent?
(a) $KMnO_4$, O_3, SO_3 (b) $HClO_4$, HNO_2, H_2O_2
(c) $HClO_2$, SO_2, H_2O_2 (d) $K_2Cr_2O_7$, SO_2, H_2SO_4

14. 1 mole of a mixture of CO and CO_2 requires exactly 1 litre solution of 1 M NaOH for complete neutralisation. If CO present in mixture is now converted to CO_2 and again the mixture is treated with NaOH, then after this conversion

(a) moles of CO_2 present initially in mixture = 1
(b) 2 litre solution of 1 M NaOH is required more for neutralisation
(c) 2 litre solution of $\frac{M}{2}$ NaOH is required more for neutralisation
(d) 40 g NaOH in aqueous solution is required more for neutralisation.

15. As per Fajan's rule, polarization (covalent character) will be increased by
(a) high charge and small size cation
(b) high charge and large size anion
(c) low charge and small size anion
(d) low charge and large size cation.

Solutions

1. (a): $\frac{r_{gas}}{r_{CH_4}} = \sqrt{\frac{M_{CH_4}}{M_{Gas}}}$; $\frac{4}{3} = \sqrt{\frac{16}{M_{gas}}}$

$M_{gas} = 9$

Density = $\frac{9}{22.4}$ = 0.4017 g/litre

As the gas is triatomatic ; atomic weight = $\frac{9}{3} = 3$

Vapour density = $\frac{\text{Mol. mass}}{2} = \frac{9}{2} = 4.5$

2. (b): $4BCl_3 + 3LiAlH_4 \xrightarrow{\text{Ether}} \underset{(A)}{2B_2H_6} + 3LiCl + 3AlCl_3$

B_2H_6 + Excess $NH_3 \xrightarrow[\text{temperature}]{\text{High}} \underset{\text{Boron nitride}}{(BN)_x}$

3. (c): Total number of lines = 4 + 3 + 2 + 1 = 10
or, Total number of lines

$= \frac{(n_2 - n_1)[(n_2 - n_1) + 1]}{2} = \frac{(6-2)(4+1)}{2} = \frac{4 \times 5}{2} = 10$

4. (c): $CaCl_2 \rightleftharpoons Ca^{2+} + 2Cl^-$

1 s $2s$ (Initial solubility = s)

$K_{sp} = 4s^3 = 4(4 \times 10^{-8})^3 = 256 \times 10^{-24}$ ...(i)

$Ca(OH)_2 \longrightarrow Ca^{2+} + 2OH^-$

C 0 0

0 C $2C$

$CaCl_2 \rightleftharpoons Ca^{2+} + 2Cl^-$

1 $s' + C$ $2s'$ (New solubility = s')

$K_{sp} = [Ca^{2+}]\,[Cl^-]^2$

$K_{sp} = [s' + C][2s']^2 = 4s'^3 + 4s'^2C$

(let s'^3 = negligible)

$K_{sp} = 4s'^2C$ ...(ii)

From equation (i) and (ii)

$s'^2 = \frac{256 \times 10^{-24}}{4 \times 10^{-2}} = 64 \times 10^{-22}$

$s' = 8 \times 10^{-11}$ mol L^{-1}

5. (a): In most of the electrophilic aromatic substitution, first step is slow and second is fast. Since first step does not involve deprotonation, hence kinetic isotopic effect is not observed in it hence, C_6H_6 and C_6D_6 react with almost same rate.

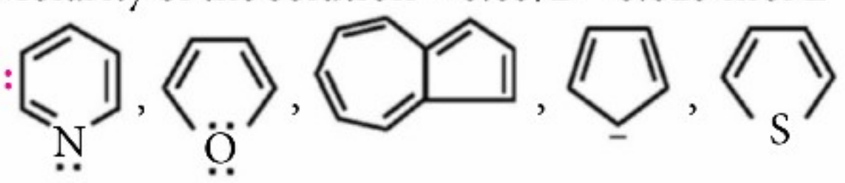
6. (a): (b) $Na_2O_2 + CO \rightarrow Na_2CO_3$
(c) Li^+ does not form alum because of its small size.

(d) $NaNO_3 \xrightarrow{500°C} NaNO_2 + \frac{1}{2}O_2$

$2NaNO_2 \xrightarrow{800°C} Na_2O + \underset{\text{(Diamagnetic)}}{N_2} + \underset{\text{(Paramagnetic)}}{\frac{3}{2}O_2}$

7. (b): Compounds (1), (3), (5) have active methylene group, hence can be extensively enolized.

8. (b): 1 L of 0.1 M H_2SO_4 contains = 0.1 mol of H_2SO_4
1 L of 0.1 M NaOH contains = 0.1 mol of NaOH
According to the given equation, 1 mol of H_2SO_4 reacts with 2 mol of NaOH. Hence, 0.1 mol of NaOH will react with 0.05 mol of H_2SO_4 (and 0.05 mol of H_2SO_4 will be left unreacted), *i.e.,* NaOH will produce 0.05 mol of Na_2SO_4
= 0.05 × (46 + 32 + 64) g = 0.05 × 142 g = 7.10 g
Volume of solution after mixing = 2 L
H_2SO_4 left unreacted in the solution = 0.05 mole
∴ Molarity of the solution = 0.05/2 = 0.025 mol L^{-1}.

9. (b): 
are aromatic compounds.

10. (c): $5 \times (H_2O_2 \rightarrow 2H^+ + O_2 + 2e^-)$
$2 \times (MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O)$
$5H_2O_2 + 2KMnO_4 + 3H_2SO_4 \rightarrow 5O_2 + 2MnSO_4 + 8H_2O + K_2SO_4$
(a) No. of g equivalent of H_2O_2 = No. of g equivalent of $KMnO_4$

(b) $\frac{\text{Moles of } MnSO_4}{\text{Moles of } O_2} = \frac{2}{5}$ (c) $E = \frac{98}{10} \times 3 = 29.4$

(d) H_2O_2 shows reducing action in acidic medium, it reduces acidified potassium permanganate solution. As a result of this reaction, the pink colour of $KMnO_4$ solution is discharged,

11. (b,c) : $T_A = T_B$; $P_B > P_A$ $\therefore$ $V_A > V_B$

$\left(P \propto \frac{1}{V} \text{ at const } T\right)$

12. (a,d) **13. (a, b, d)**

14. (c,d) : $2NaOH + CO_2 \longrightarrow Na_2CO_3 + H_2O$

1 mole $\frac{1}{2}$ mole

$n_{CO} + n_{CO_2} = 1$

$n_{CO} = \frac{1}{2}$

$CO + \frac{1}{2}O_2 \longrightarrow CO_2$

$\frac{1}{2}$ mole $\frac{1}{2}$ mole

More NaOH required = 1 mole

So, $\frac{1}{2}$M NaOH = 2 litre

$n = M \times V = \frac{1}{2} \times 2 = 1$ mole

Similarly 1 mole of NaOH is required = 40 g = 1 mole.

15. (a,b) : Size of cation decreases, size of anion increases, covalent character increases.

Scientist who Made Us Proud

Asima Chatterjee was an Indian organic chemist noted for her work in the fields of organic chemistry and phytomedicine. Her most notable work includes research on vinca alkaloids, the development of anti-epileptic drugs, and development of anti-malarial drugs. She also authored a considerable volume of work on medicinal plants of the Indian subcontinent.

Asima Chatterjee
(23 Sept 1917 - 22 Nov 2006)

Early Life and Education

Asima Chatterjee was born on 23 September 1917 in Bengal. Chatterjee grew up in Calcutta in a middle-class family where she was encouraged to get an education. She graduated with honors in chemistry from the Scottish Church College of the University of Calcutta in 1936.

Asima Chatterjee received a master's degree (1938) and a doctoral degree (1944) in organic chemistry from the University of Calcutta. She was the first Indian woman to earn a doctorate in science. Her doctoral research focused on the chemistry of plant products and synthetic organic chemistry. Additionally, she had research experience from the University of Wisconsin, Madison and Caltech with László Zechmeister.

Research and Contributions

- Chatterjee's research concentrated on natural product's chemistry and resulted in anti-convulsive, anti-malarial, and chemotherapy drugs. She spent around forty years researching various alkaloid compounds.
- She also discovered anti-epileptic activity in Marsilea minuta and anti-malarial activity in the plants Alstonia scholaris, Swertia chirata, Picrorhiza kurroa and Caesalpinia crista. These agents, however, have not been shown to be clinically competitive with the medications currently used for these conditions. Her work led to the development of an epilepsy drug called Ayush-56 and several anti-malarial drugs.
- Initiated chemical investigation of alkaloids in Rauwolfia canescens.
- Investigated the chemistry of almost all principal types of indole alkaloids.
- First suggested stereo-configuration of sarpagine.
- Isolated and characterised geissoschizine, a key precursor in biogenesis of indole alkaloids from Rhazya stricta.
- Carried out synthetic studies on a number of complex indole, quinoline and isoquinoline alkaloids.
- Developed procedures for the preparation of beta-phenylethanolamines in connection with alkaloid synthesis.
- Elucidated the structure of luvangetin isolated from Luvanga scandens.
- Studied the action of various Lewis acids on prenylated coumarins and devised simple synthetic routes to a number of complex coumarin systems.
- Investigated the mechanism of acid-catalysed hydramine fission of beta phenylethanol amines.
- Introduced the use of periodic acid as a reagent for the detection and location of both terminal and exocyclic double bonds in organic compounds.

Awards and Recognition

- She was a Premchand Roychand Scholar of the University of Calcutta.
- From 1962 to 1982, she was the Khaira Professor of Chemistry, one of the most prestigious and coveted chairs of the University of Calcutta.
- In 1972, she was appointed as the Honorary Coordinator of the Special Assistance Programme to intensify teaching and research in natural product chemistry, sanctioned by the Indian University Grants Commission.
- In 1960, she was elected as a Fellow of the Indian National Science Academy, New Delhi.
- In 1961, she received the Shanti Swarup Bhatnagar Award in chemical science, becoming the first female recipient of this award.
- In 1975, she was conferred the prestigious Padma Bhushan and became the first female scientist to be elected as the General President of the Indian Science Congress Association.
- She was nominated by the President of India as a Member of the Rajya Sabha from February 1982 to May 1990.
- On 23 September 2017, the search engine Google deployed a 24-hour Google Doodle in honour of the 100th anniversary of Chatterjee's birth.

CLASS-XI

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2020

Unit 5

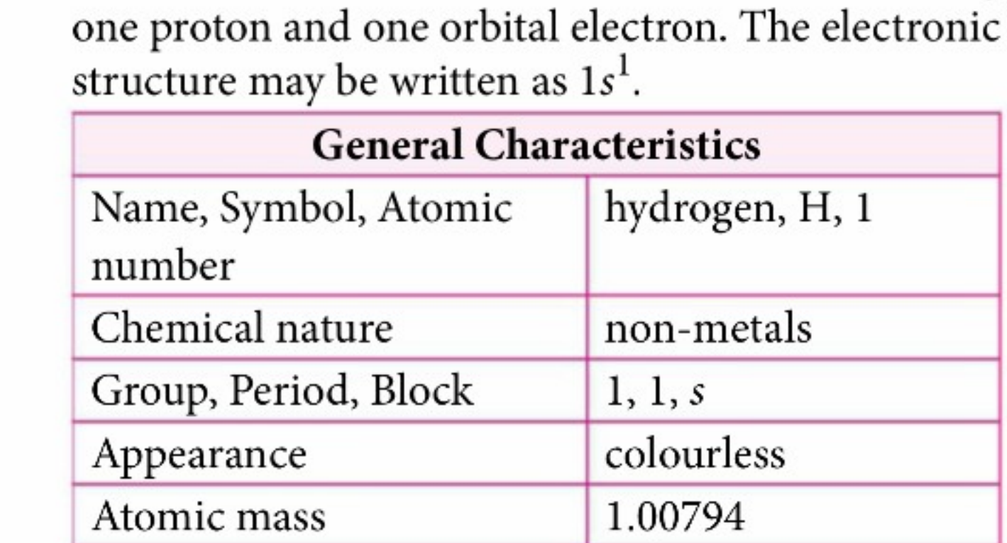
Hydrogen | *s*-Block Elements

Hydrogen

- Hydrogen is the most abundant element in the universe.
- Hydrogen has the simplest atomic structure of all the elements, and consists of a nucleus containing one proton and one orbital electron. The electronic structure may be written as $1s^1$.

General Characteristics	
Name, Symbol, Atomic number	hydrogen, H, 1
Chemical nature	non-metals
Group, Period, Block	1, 1, *s*
Appearance	colourless
Atomic mass	1.00794
Electronic configuration	$1s^1$
Electrons per shell	1

Isotopes



- **Bond Energy and Reactivity**
  Bond energy : $H_2 < D_2 < T_2$
  Reactivity : $H_2 > D_2 > T_2$
- The difference in the properties of isotopes which arises due to difference in their atomic masses is called isotopic effect.

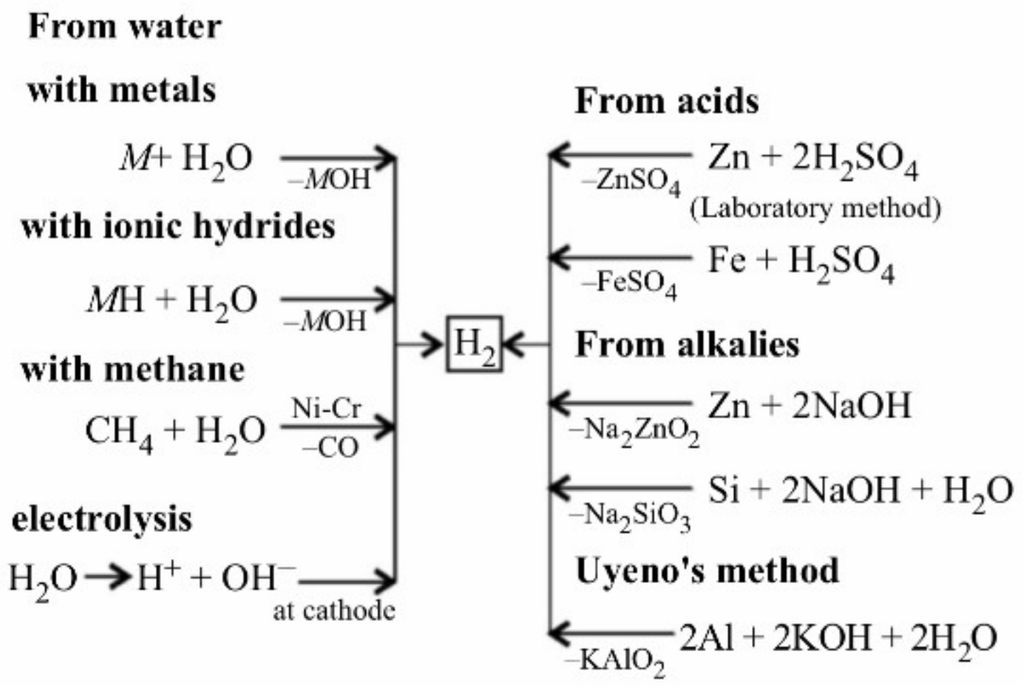
Allotropes

Ortho-hydrogen
(Parallel nuclear spin *i.e.*, spins of both protons in hydrogen molecule are in the same direction.)

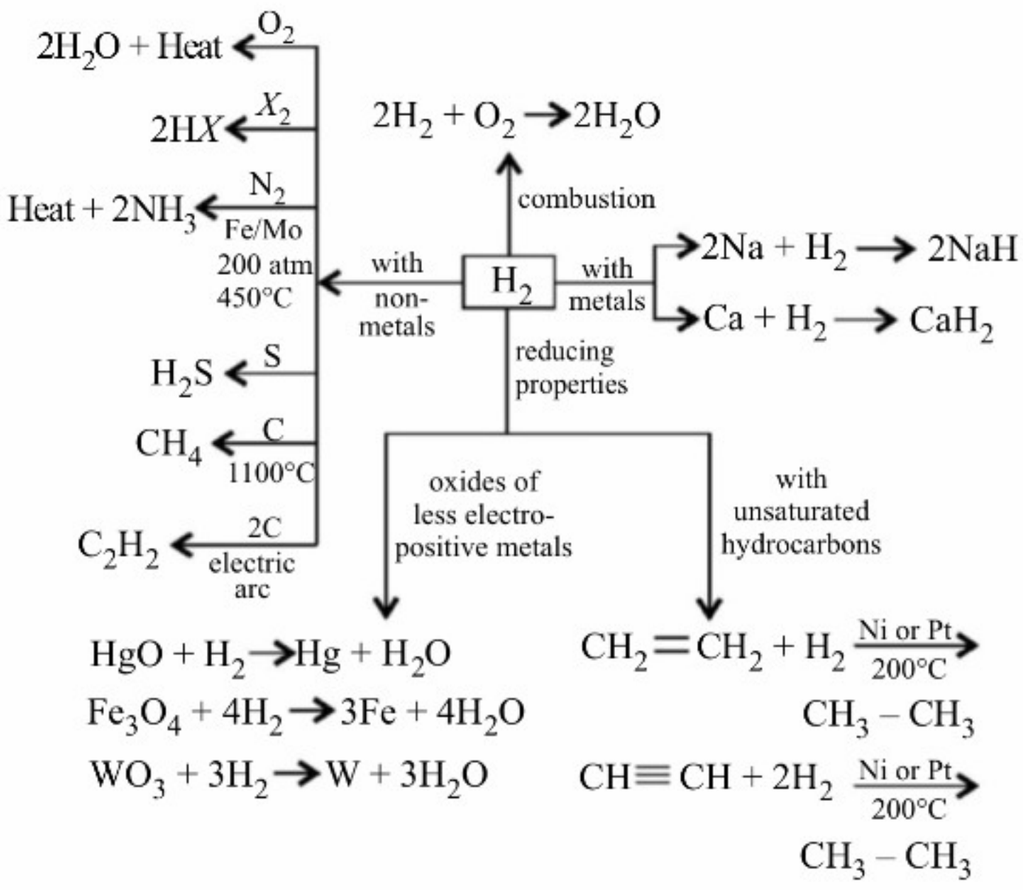
Para-hydrogen
(Anti-parallel nuclear spin *i.e.*, spins of both protons in hydrogen molecule are in the opposite directions.)

- At room temperature, ordinary hydrogen contains 75% *ortho*-hydrogen and 25% *para*-hydrogen. As the temperature decreases, the percentage of *ortho* hydrogen in the mixture decreases. Pure *para* hydrogen can be prepared by cooling nearly to absolute zero but pure *ortho* hydrogen cannot be prepared.
- **Stability :** *Ortho* hydrogen > *Para* hydrogen.
- Differences in physical properties of both is because of differences in internal energy of both.
- Internal energy of *ortho* H_2 > *para* H_2.

Preparation of Hydrogen



Chemical Properties of Hydrogen



Hydrides

- Dihydrogen, under certain reaction conditions, combines with almost all elements except noble gases to form binary compounds called hydrides. If '*E*' is the symbol of an element, then hydride can be expressed as EH_x (*e.g.*, MgH_2) or E_mH_n (*e.g.*, B_2H_6).

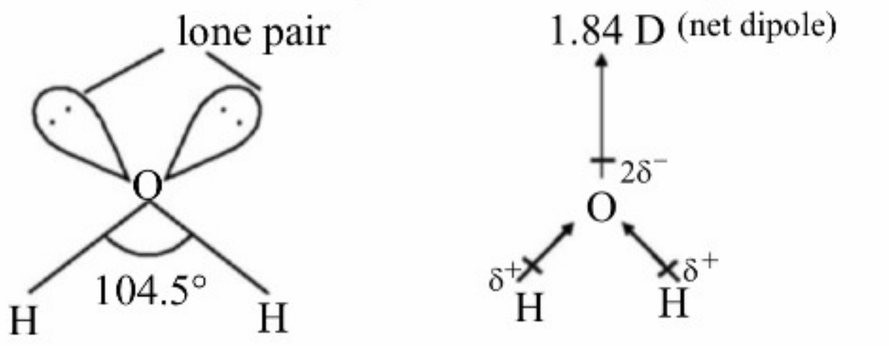
Classification of Hydrides

Ionic hydrides	These are formed by transfer of electrons from most of the *s*-block elements (electropositive metals) to hydrogen atom. *e.g.*, $2Li_{(s)} + H_{2(g)} \xrightarrow{973\ K} 2LiH_{(s)}$ $2Na_{(s)} + H_{2(g)} \xrightarrow{973\ K} 2NaH_{(s)}$
Molecular or covalent hydrides	Compounds of hydrogen with *p*-block elements and some *s*-block elements (Be & Mg). In some cases partly covalent and partly ionic character is found, *e.g.*, HF. $N_2 + 3H_2 \xrightarrow{\text{catalyst, 750 K}} 2NH_3$ $CaC_2 + 2H_2O \longrightarrow Ca(OH)_2 + C_2H_2$
Metallic or interstitial hydrides	Compounds of hydrogen with *d*-block and *f*-block metals. These are non-stoichiometric and show electric conduction.

- Elements of groups 7, 8, 9 do not form hydrides. This region of periodic table is referred to as hydride gap.

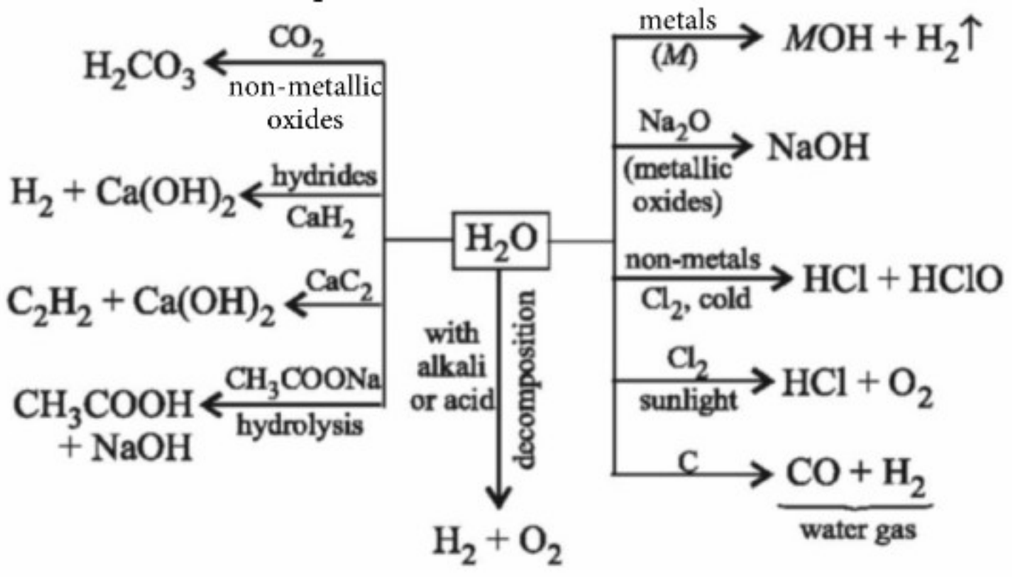
Water

- Water is a covalent molecule in which oxygen undergoes sp^3 hybridisation and contains two lone pairs.
- Due to the presence of two lone pairs of electrons on the oxygen atom, the H—O—H bond angle is 104.5°. Molecule is angular or bent in shape.



- In solid state (ice) water molecules are arranged in highly ordered three dimensional open cage like structure through hydrogen bonding.
- This arrangement leads to a packing with large open spaces and results in lower density of ice than that of liquid water.

Chemical Properties



Hard and Soft Water

- **Soft water :** Water which forms lather with soap easily is called soft water.
- **Hard water :** Water which does not form lather with soap easily and hence is unfit for washing is called hard water.

Types of Hard Water

Permanent hardness : It is due to the presence of soluble chlorides and sulphates of Ca and Mg. It can be removed by treating it with Na_2CO_3.

$CaSO_4 + Na_2CO_3 \rightleftharpoons CaCO_3\downarrow + Na_2SO_4$

$MgCl_2 + Na_2CO_3 \rightleftharpoons MgCO_3\downarrow + 2NaCl$

Removal of permanent hardness is affected by ion exchangers like zeolite, permutit and synthetic resins, etc.

Temporary hardness : It is due to the presence of bicarbonates of Ca and Mg. It can be removed by

(a) Boiling :

$$\underset{\text{Soluble bicarbonates}}{M(HCO_3)_2} \xrightleftharpoons{\Delta} \underset{\text{Insoluble carbonates}}{MCO_3\downarrow} + H_2O + CO_2\uparrow$$

Here, M = Mg or Ca

(b) Clark's process :

$Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow 2CaCO_3\downarrow + 2H_2O$

Heavy Water (D_2O)

- Discovered by Urey.
- It is obtained from ordinary water by prolonged electrolysis.
- Heavy water is colourless, odourless and tasteless mobile liquid. Nearly all the physical constants are higher than the corresponding values of ordinary water.

Chemical Properties of Heavy Water

- Heavy water is chemically similar to ordinary water, However D_2O reacts slowly than H_2O.
- $SO_3 + D_2O \rightarrow \underset{\text{Deuterosulphuric acid}}{D_2SO_4}$
- $\underset{\text{Aluminium carbide}}{Al_4C_3} + 12D_2O \rightarrow \underset{\text{Deutero methane}}{3CD_4} + 4Al(OD)_3$
- $\underset{\text{Calcium carbide}}{CaC_2} + 2D_2O \rightarrow \underset{\text{Deutero ethyne}}{DC\equiv CD} + Ca(OD)_2$

Uses :

- As a neutron moderator in nuclear reactors.
- For the preparation of deuterium.
- As a tracer compound for studying reaction mechanisms.

Peep Into Previous Years

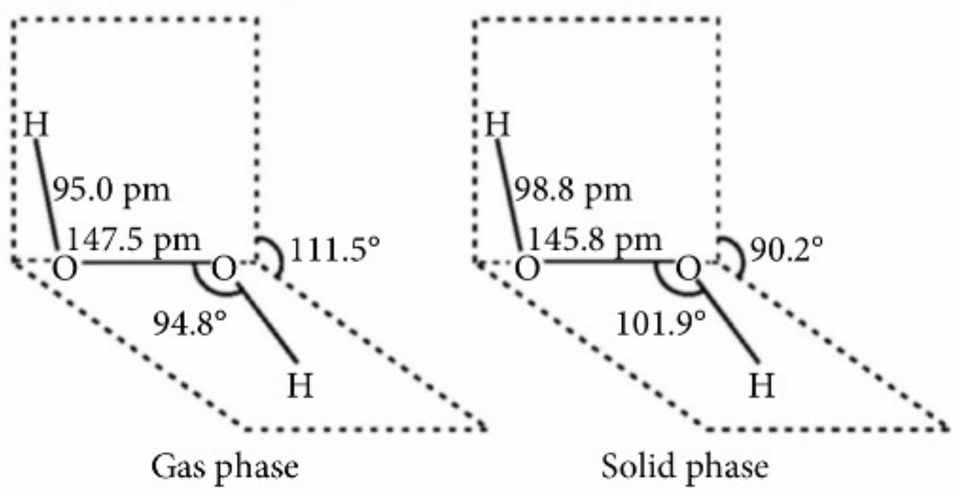
1. The correct statements among (I) to (IV) are :
   I. Saline hydrides produce H_2 gas when react with H_2O.
   II. Reaction of $LiAlH_4$ with BF_3 leads to B_2H_6.
   III. PH_3 and CH_4 are electron - rich and electron-precise hydrides, respectively.
   IV. HF and CH_4 are called as molecular hydrides.
   (a) I, II, III and IV (b) III and IV only
   (c) I, III and IV only (d) I, II and III only
   (JEE Main 2019)

2. The method used to remove temporary hardness of water is
   (a) synthetic resins method
   (b) Calgon's method
   (c) Clark's method
   (d) ion-exchange method. ***(NEET 2019)***

Hydrogen Peroxide or Oxygenated Water (H_2O_2)

- It is the hydride of oxygen.
- Its boiling point is higher than H_2O due to the presence of stronger intermolecular hydrogen bonding than in water.
- **Structure :**

H_2O_2 has an open book like (non-planar) structure.



Preparation

From sodium peroxide

$$Na_2O_2 + 2H_2O \xrightarrow[\text{Ice-cold}]{} 2NaOH + H_2O_2$$

Merck's process :

$$Na_2O_2 + \underset{\substack{\text{Dilute (20\%)}\\\text{(cold)}}}{H_2SO_4} \longrightarrow Na_2SO_4 + H_2O_2$$

From barium peroxide

$$BaO_2 \cdot 8H_2O + \underset{\text{Ice-cold}}{H_2SO_4} \longrightarrow BaSO_4 + H_2O_2 + 8H_2O$$

$$3BaO_2 + 2H_3PO_4 \longrightarrow Ba_3(PO_4)_2\downarrow + 3H_2O_2$$

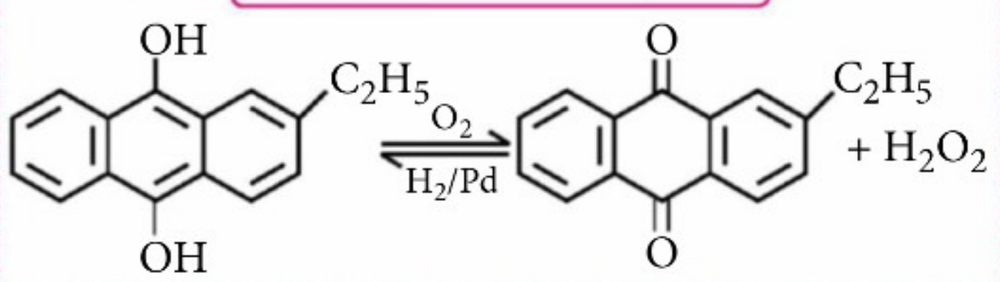
$$BaO_2 + CO_2 + H_2O \longrightarrow BaCO_3\downarrow + H_2O_2$$

From electrolysis of $(NH_4)_2SO_4$ and H_2SO_4

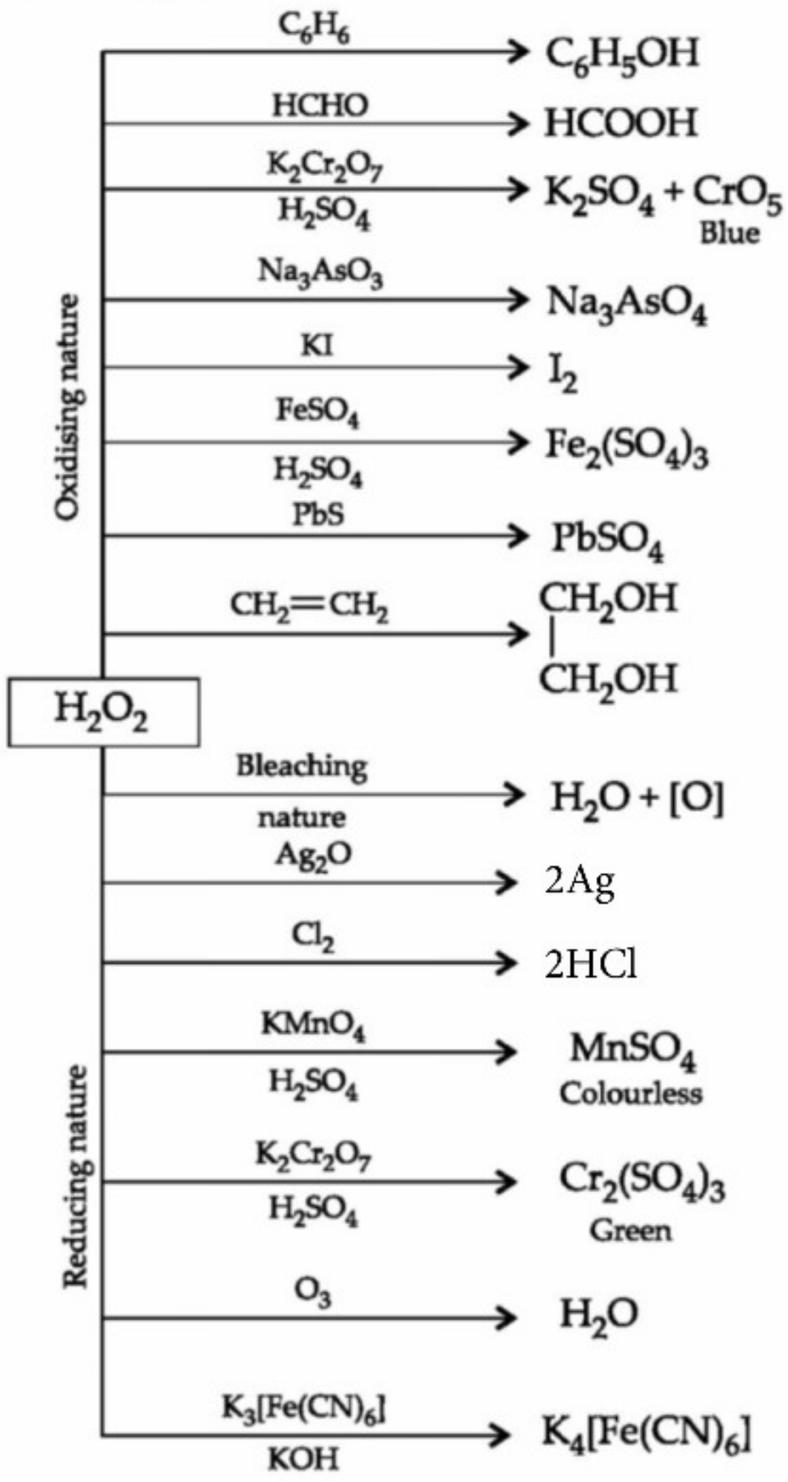
$$(NH_4)_2SO_4 + H_2SO_4 \xrightarrow{\text{Electrolysis}} 2NH_4HSO_4$$

$$(NH_4)_2S_2O_8 \xrightarrow{2H_2O} 2NH_4HSO_4 + H_2O_2$$

From 2-ethylanthraquinol



Chemical Properties



Uses

- As an antiseptic.
- As an antichlor.
- As an oxidant for rocket fuel.
- Used to control pollution.
- Restores the colour of the old lead paintings.

Strength of Hydrogen Peroxide Solution

- **Volume strength of H_2O_2 :** Volume strength of H_2O_2 means the volume of O_2 released by decomposition of 1 volume H_2O_2. For example, H_2O_2 of x volume strength means 1 mL or 1 L of H_2O_2 on decomposition gives x mL or x L of oxygen respectively.

$$\underset{2 \times 34\ g}{2H_2O_2} \longrightarrow 2H_2O + \underset{22.4\ L\ at\ STP}{O_2}$$

i.e., 22.4 L of oxygen is released from 68 g H_2O_2, then x L of oxygen will be released from

$$= \frac{68}{22.4} \times x = \frac{17x}{5.6} \text{ g of } H_2O_2$$

$$\text{Strength} = \frac{17x}{5.6} \text{ g/L}$$

- $\text{Normality} = \dfrac{\text{Strength}}{\text{Equivalent weight}} = \dfrac{17x}{5.6} \times \dfrac{1}{17} = \dfrac{x}{5.6}$

$\therefore$ Normality of H_2O_2 solution

$$= \frac{\text{Volume strength of } H_2O_2}{5.6}$$

- $\text{Molarity} = \dfrac{\text{Normality}}{2} = \dfrac{x}{11.2}$ (Valency factor = 2)

$\therefore$ Molarity of H_2O_2 solution

$$= \frac{\text{Volume strength of } H_2O_2}{11.2}$$

Peep Into Previous Years

3. The chemical nature of hydrogen peroxide is
   (a) oxidising and reducing agent in both acidic and basic medium
   (b) oxidising agent in acidic medium, but not in basic medium
   (c) oxidising and reducing agent in acidic medium, but not in basic medium
   (d) reducing agent in basic medium, but not in acidic medium. ***(JEE Main 2019)***

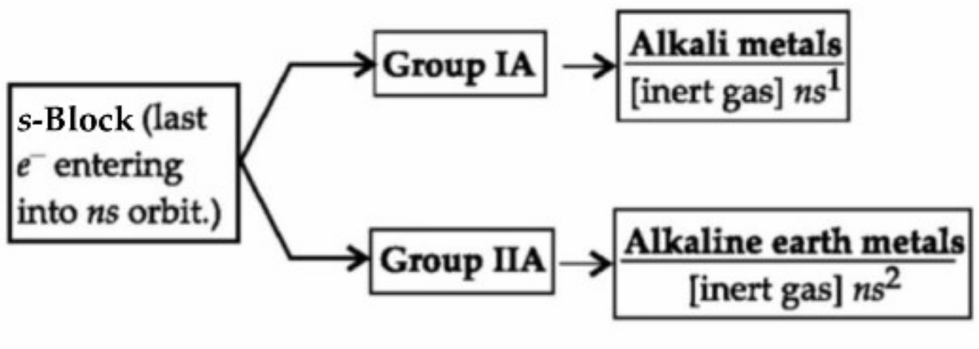
4. Hydrogen peroxide oxidises $[Fe(CN)_6]^{4-}$ to $[Fe(CN)_6]^{3-}$ in acidic medium but reduces $[Fe(CN)_6]^{3-}$ to $[Fe(CN)_6]^{4-}$ in alkaline medium. The other products formed are, respectively
   (a) $(H_2O + O_2)$ and H_2O
   (b) $(H_2O + O_2)$ and $(H_2O + OH^-)$
   (c) H_2O and $(H_2O + O_2)$
   (d) H_2O and $(H_2O + OH^-)$ ***(JEE Main 2018)***

Points For Extra Scoring

- **Nascent hydrogen :** Hydrogen at the moment of formation is know as nascent hydrogen. It can reduce compounds that do not readily react with normal hydrogen.
  e.g., $Zn + H_2SO_4 \rightarrow ZnSO_4 + 2H$
  (Nascent hydrogen)
- **Adsorbed or occluded hydrogen :** Some metals (*e.g.*, Pd, Pt, Au, Fe, Ni) can adsorb under certain conditions relatively large volumes of hydrogen. For example, one volume of palladium adsorbs 935 volumes of hydrogen while cooling from red heat. The gas thus adsorbed by metals is given off when the metal is heated especially under reduced pressure. The phenomenon was termed as occlusion or adsorption by Graham.
- **Active hydrogen** : When ordinary hydrogen at room temperature is subjected to the action of silent electric discharge at an electrical pressure more than 30,000 volts, it changes into an active variety of hydrogen. This is called active hydrogen.
- **Atomic hydrogen :** When hydrogen is passed through an electric arc established between two tungsten filaments, hydrogen is dissociated into atoms. This form of hydrogen is known as atomic hydrogen. The life period of atomic hydrogen is 0.3 seconds. It readily returns to ordinary form.
- Hydrogen forms polymeric hydrides like $(BeH_2)_n$, $(AlH_3)_n$, $(InH_3)_n$, $(GaH_3)_n$, $(SiH_4)_n$ etc. with elements having electronegativity in the range of 1.40 to 2.0 and also forms complex hydrides like $NaBH_4$, $LiBH_4$, $LiAlH_4$ where, H^- acts as a ligand.

s-Block Elements

The *s*-block elements are those in which the last electron enters the outermost *s*-orbital. Two groups (1 and 2) belongs to the *s*-block of periodic table.



Group 1 Elements : Alkali Metals

Property	Li	Na	K	Rb	Cs	Fr
At. no. (Z)	3	11	19	37	55	87
Electronic configuration	[He] $2s^1$	[Ne] $3s^1$	[Ar] $4s^1$	[Kr] $5s^1$	[Xe] $6s^1$	[Rn] $7s^1$

Physical Properties

Physical state : Alkali metals are silvery white, soft and light metals. They have only one valence electron, so the metallic bond is not so strong which makes them soft metals.

Hydration of ions : Degree of hydration of alkali metal ions decreases in the order : $Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$.

Oxidation state : All the alkali metals exhibit an oxidation state of +1.

Conductivity : Increases down the group due to the presence of loosely held valence electron which is free to move throughout the metal structure.

Density : Increase from Li to Cs. However, potassium is lighter than sodium (anomaly) due to an unusual increase in atomic size of potassium.

Group 1 Elements (ns^1)

Electropositive or metallic character : Alkali metals are strongly electropositive because of their low ionisation energies.

Melting and boiling points : Due to weak intermetallic bonding, alkali metals have very low m.pt. and b.pt.

Flame colouration : All the alkali metals impart a characteristic colouration to the flame.

Li	Na	K	Rb	Cs
Crimson red	Golden yellow	Pale violet	Violet	Violet

Gradation in Properties

Atomic radii Atomic volume Density Reducing power Electropositivity Large anion stabilisation	Increases ↓	Li Na K Rb Cs	Increases ↑	M.pt. and b.pt. Hardness Ionisation enthalpy Heat of atomization Hydration enthalpy Electronegativity

Diagonal relationship between lithium and magnesium

- Lithium shows diagonal relationship with magnesium since they have the same charge/size ratio *i.e.* polarising power.
- Li and Mg show close resemblance in the following :

Nitrides	Li and Mg both form nitrides. Other alkali metals do not. $6Li + N_2 \xrightarrow{\Delta} 2Li_3N$, $3Mg + N_2 \xrightarrow{\Delta} Mg_3N_2$
Carbonates	Like $MgCO_3$, Li_2CO_3 is decomposed by heat (the other alkali carbonates are thermally stable). $MgCO_3 \xrightarrow{\Delta} MgO + CO_2$, $Li_2CO_3 \xrightarrow{\Delta} Li_2O + CO_2$
Nitrates	$LiNO_3$ decomposes to give Li_2O like $Mg(NO_3)_2$, but other alkali metal nitrates give nitrite. $Mg(NO_3)_2 \xrightarrow{\Delta} MgO + 2NO_2 + 1/2O_2$; $2LiNO_3 \xrightarrow{\Delta} Li_2O + 2NO_2 + 1/2O_2$
Oxides	Both give their normal oxides (Li_2O, MgO) when they burn in oxygen.
Hydration	Both Li^+ and Mg^{2+} are heavily hydrated.

Anomalous Behaviour of Li

All alkali metals	Li
Do not react directly with N_2 or C.	Forms Li_3N or Li_2C_2
Form amide (MNH_2) with ammonia.	Forms Li_2NH
Nitrates are thermally stable.	$LiNO_3$ is Not Stable
Carbonates are thermally stable.	$Li_2CO_3 \xrightarrow{\Delta} Li_2O + CO_2$
Form double salts (alums) from their sulphates.	Forms Li_2SO_4

Chemical Properties

Chemical properties

Reaction with oxygen

$4M + O_2 \longrightarrow 2M_2O$
(where, M = Li, Na, K, Rb, Cs)

When heated with excess of air.

$4Li + O_2 \longrightarrow 2Li_2O$
(Lithium oxide)

$2Na + O_2 \xrightarrow{575\ K} Na_2O_2$
(Sodium peroxide)

Reaction with water

$2Na + 2H_2O \longrightarrow 2NaOH + H_2$

Solution in liquid ammonia

$M + (x + y)NH_3 \longrightarrow [M(NH_3)_x]^+ + [e(NH_3)_y]^-$

Ammoniated cation responsible for conductivity

Ammoniated electron responsible for blue colour and paramagnetism

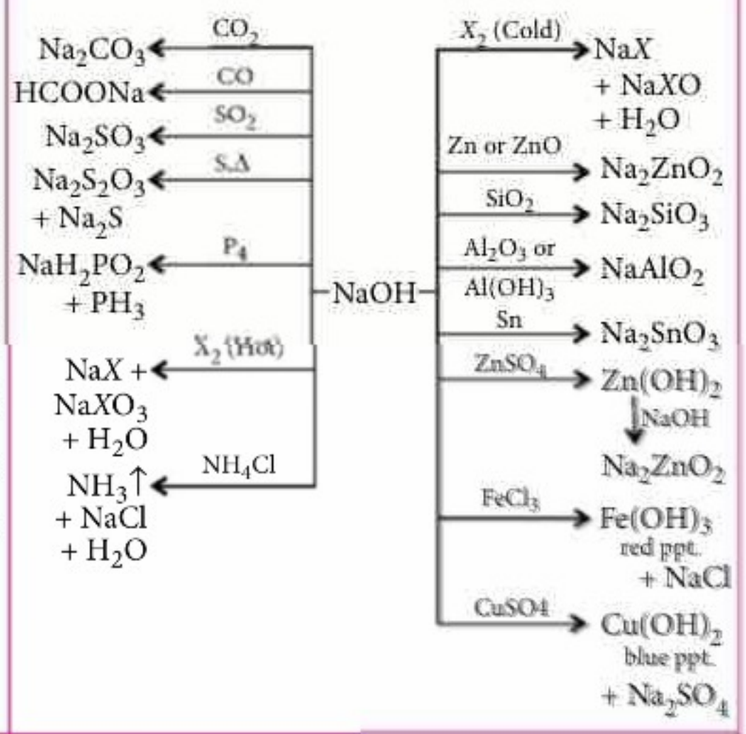
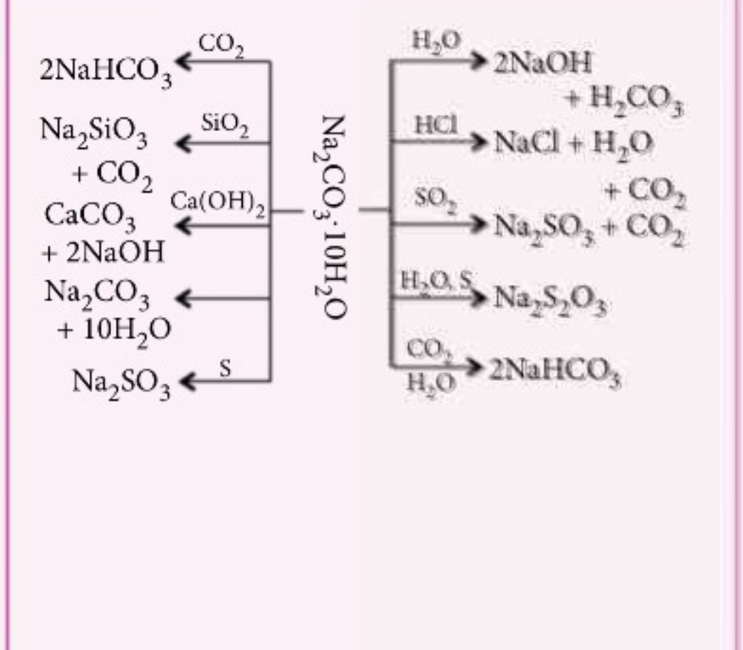
Reaction with hydrogen

$2M + H_2 \xrightarrow{\Delta} 2MH$ (M = Li, Na, K, Rb or Cs)

Reaction with halogens

$2M + X_2 \longrightarrow 2MX$
(where, M = Li, Na, K, Rb or Cs and X = F, Cl, Br or I)

Some Important Compounds of Sodium

Compound	Preparation	Properties	
		Physical	Chemical
Sodium hydroxide or caustic soda (NaOH)	Electrolytic process in mercury cathode cell $2NaCl_{(aq)} + 2H_2O_{(l)} \longrightarrow \underbrace{H_{2(g)}}_{\text{At cathode}} + \underbrace{Cl_{2(g)} + 2NaOH_{(aq)}}_{\text{At anode}}$	NaOH is deliquescent, white crystalline solid. NaOH dissolves readily in water to yield highly alkaline solution which is corrosive, soapy in touch and bitter in taste.	
Sodium carbonate or washing soda ($Na_2CO_3 \cdot 10H_2O$)	Sodium carbonate is manufactured by Solvay process. Brine solution is saturated with ammonia and then made to react with CO_2. Sodium bicarbonate being sparingly soluble, crystallises out. This is finally calcined to form sodium carbonate. $NH_3 + NaCl + H_2O + CO_2 \longrightarrow NaHCO_3\downarrow + NH_4Cl$ $2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + H_2O + CO_2$	$Na_2CO_3 . 10H_2O$ is a white crystalline solid which effloresces in air to given the powdery monohydrate $Na_2CO_3 \cdot H_2O$, which on heating gives anhydrous amorphous sodium carbonate called soda ash.	

Sodium hydrogen carbonate or baking soda ($NaHCO_3$)	Obtained as an intermediate product in Solvay process. $NaCl + NH_3 + CO_2 + H_2O \longrightarrow NaHCO_3 + NH_4Cl$ It can also be prepared by passing CO_2 through solution of sodium carbonate. $Na_2CO_3 + CO_2 + H_2O \longrightarrow 2NaHCO_3$	It is a white crystalline powder and less soluble than sodium carbonate. It is weakly alkaline which gives yellow colour with methyl orange but no colour with phenolphthalein.	$NaHCO_3$ on heating decomposes to produce bubbles of CO_2 which make the cakes and pastries fluffy. $2NaHCO_3 \xrightarrow[100°C]{\Delta} Na_2CO_3 + H_2O + CO_2$ It is amphiprotic *i.e.*, it can act as H^+ donor as well as H^+ acceptor. $HCO_3^- + H^+ \rightleftharpoons H_2CO_3$; $HCO_3^- \rightleftharpoons H^+ + CO_3^{2-}$

Peep Into Previous Years

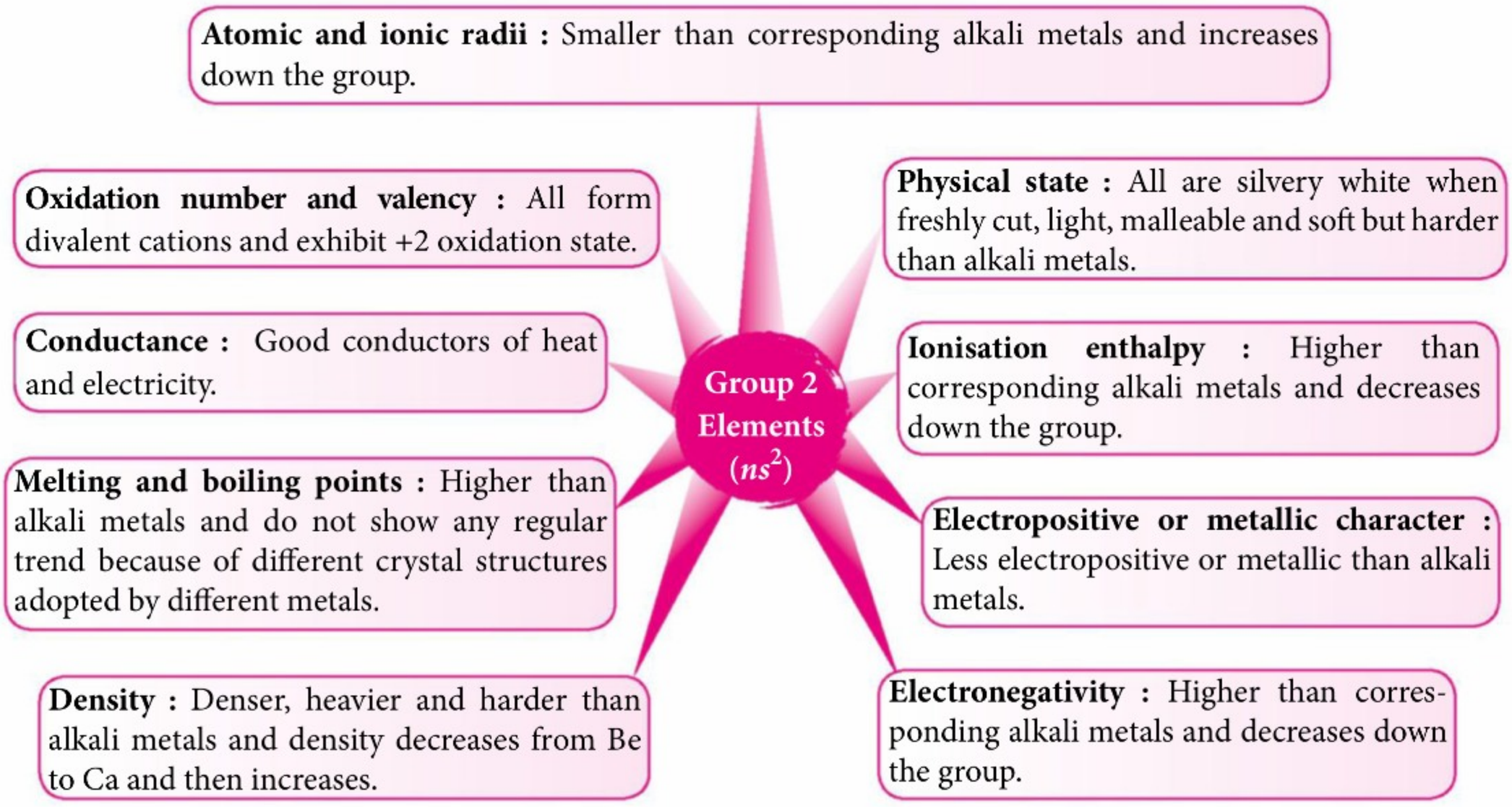
5. In KO_2, the nature of oxygen species and the oxidation state of oxygen atom are, respectively
(a) superoxide and –1/2 (b) oxide and –2
(c) peroxide and –1/2 (d) superoxide and –1.
(JEE Main 2018)

6. Both lithium and magnesium display several similar properties due to the diagonal relationship, however, the one which is incorrect, is
(a) both form nitrides
(b) nitrates of both Li and Mg yield NO_2 and O_2 on heating
(c) both form basic carbonates
(d) both form soluble bicarbonates.
(JEE Main 2016)

Group 2 Elements : Alkaline Earth Metals

Property	Be	Mg	Ca	Sr	Ba	Ra
At. no. (Z)	4	12	20	38	56	88
Electronic configuration	[He] $2s^2$	[Ne] $3s^2$	[Ar] $4s^2$	[Kr] $5s^2$	[Xe] $6s^2$	[Rn] $7s^2$

Physical Properties



Gradation in Properties

Atomic radii Electropositivity Reducing power Stability of carbonates, hydroxides and sulphates Solubility and basic strength of oxides and hydroxides	Increases ↓	Be Mg Ca Sr Ba	↑ Increases	Ionization enthalpy Electronegativity Hydration enthalpy Solubility of carbonates and bicarbonates Solubility of halides

Anomalous Behaviour of Be

All alkaline earth metals	Be
Form ionic non-volatile nitrides.	Be_3N_2 is covalent and volatile.
Form ionic carbonates.	$BeCO_3$ is unstable.
Form basic oxides.	BeO is amphoteric.

Diagonal Relationship Between Be and Al

- The similarity between Be and Al arises due to their same electronegativity, polarising power and the charge / radius ratio of their ions.
- Be^{2+} and Al^{3+} favour covalent bonding due to same charge to radius ratio.
- Both become passive on treating with conc. HNO_3.
- Both Be_2C and Al_4C_3 on hydrolysis give methane.

$$Be_2C + 4H_2O \rightarrow 2Be(OH)_2 + CH_4$$
$$Al_4C_3 + 12H_2O \rightarrow 4Al(OH)_3 + 3CH_4$$

- $Be(OH)_2$ dissolves in excess of alkali to give a beryllate ion $[Be(OH)_4]^{2-}$, $Al(OH)_3$ gives aluminate ion $[Al(OH)_4]^-$.
- Both Be and Al form complexes like $[BeF_4]^{2-}$ and $[AlF_6]^{3-}$.
- Both BeO and Al_2O_3 or $Be(OH)_2$ and $Al(OH)_3$ are amphoteric in nature.

Chemical Properties

Chemical properties

Reaction with hydrogen (formation of hydrides)

All the alkaline earth metals except Be combine with hydrogen directly on heating to form metal hydrides of formula, MH_2.

$$M + H_2 \xrightarrow{\Delta} MH_2$$

Reaction with halogens

They react with halogens at elevated temperature to form the halides of the type MX_2.

Reaction with ammonia

Like alkali metals, the alkaline earth metals dissolve in liquid ammonia to give deep blue-black solution from which ammoniates $[M(NH_3)_6]^{2+}$ can be recovered.

Reaction with carbon

When BeO is heated with carbon at 2175 – 2275 K a brick red coloured carbide is formed.

$$2BeO + 3C \xrightarrow{2175-2275\ K} Be_2C + 2CO$$
$$Be_2C + 4H_2O \rightarrow 2Be(OH)_2 + CH_4$$

Action of acids

They readily react with acids liberating hydrogen.

$M + 2HCl \rightarrow MCl_2 + H_2$ (M = Be, Mg, Ca, Sr, Ba)

Some Important Compounds of Calcium

Compound	Preparation	Properties	
		Physical	Chemical
Calcium oxide or quick lime (CaO)	$CaCO_3 \underset{}{\overset{1070-1270\ K}{\rightleftharpoons}} CaO + CO_2$ Limestone	CaO is white amorphous solid having m.pt. 2870 K.	$Ca(OH)_2 \xleftarrow{H_2O} CaO \xrightarrow{SiO_2} CaSiO_3$ $CaCO_3 \xleftarrow{CO_2} CaO \xrightarrow{P_4O_{10}} Ca_3(PO_4)_2$ **Uses :** It is used as a basic lining in furnaces.

Calcium hydroxide or slaked lime $Ca(OH)_2$	$CaO + H_2O \rightarrow Ca(OH)_2$ $CaCl_2 + 2NaOH \rightarrow Ca(OH)_2 + 2NaCl$	It is a white amorphous powder which is sparingly soluble in water. The aqueous solution is known as lime water and a suspension of slaked lime in water is known as milk of lime.	$CaCl_2 + Ca(OCl)_2 + 2H_2O \xleftarrow{\text{below } 35^\circ C,\ Cl_2}$ Bleaching Powder $CaCl_2 + H_2O + O_2 \xleftarrow{\text{Red hot } Cl_2}$ $CaCl_2 + NH_3 + H_2O \xleftarrow[\Delta]{NH_4Cl}$ $Ca(OH)_2 \xrightarrow{CO_2} CaCO_3\downarrow$ $\xrightarrow{SO_2} CaSO_3$ $\xrightarrow{H_2O + CO_2} Ca(HCO_3)_2$ $\xrightarrow{Na_2CO_3} 2NaOH + CaCO_3\downarrow$ **Uses :** It is used for white washing and for softening of water.
Calcium carbonate ($CaCO_3$)	$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$ $CaCl_2 + Na_2CO_3 \rightarrow CaCO_3 + 2NaCl$	$CaCO_3$ is a white fluffy powder, insoluble in water.	$CaCO_3 \xrightarrow{1200\ K} CaO + CO_2$ $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$ $CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + H_2O + CO_2$ **Uses :** It is used as precipitated chalk in tooth-pastes, cosmetic powder etc.
Plaster of Paris or hemihydrate calcium sulphate ($CaSO_4 \cdot \frac{1}{2}H_2O$)	$2(CaSO_4 \cdot 2H_2O) \xrightarrow{393\ K}$ Gypsum $2(CaSO_4) \cdot H_2O + 3H_2O$ Plaster of Paris If heated above 393 K, anhydrous $CaSO_4$ is formed called dead burnt plaster.	It is a white powder. It has a remarkable property of setting with water. On mixing with an adequate quantity of water it forms a plastic mass that gets into a hard solid in 5-15 minutes.	$2(CaSO_4) \cdot H_2O \xrightarrow[H_2O]{\text{Setting}} CaSO_4 \cdot 2H_2O$ Orthorhombic $\downarrow$ Hardening $CaSO_4 \cdot 2H_2O$ Monoclinic $2(CaSO_4) \cdot H_2O \xrightarrow[200^\circ C]{\Delta} CaSO_{4(anhy.)}$ Dead burnt plaster **Uses :** It is used for setting broken or dislocated bones, in making casts for statues, toys etc.

Peep Into Previous Years

7. The alkaline earth metal nitrate that does not crystallise with water molecules is

(a) $Ba(NO_3)_2$ (b) $Ca(NO_3)_2$

(c) $Sr(NO_3)_2$ (d) $Mg(NO_3)_2$

(JEE Main 2019)

8. The covalent alkaline earth metal halide (X = Cl, Br, I) is

(a) CaX_2 (b) BeX_2 (c) MgX_2 (d) SrX_2

(JEE Main 2019)

9. Among CaH_2, BeH_2, BaH_2, the order of ionic character is

(a) $BeH_2 < CaH_2 < BaH_2$

(b) $CaH_2 < BeH_2 < BaH_2$

(c) $BeH_2 < BaH_2 < CaH_2$

(d) $BaH_2 < BeH_2 < CaH_2$ ***(NEET 2018)***

Points For Extra Scoring

- The order of hydration of ions : $Cs^+ < Ba^{2+} < Rb^+ < Sr^{2+} < K^+ < Ca^{2+} < Na^+ < Mg^{2+} < Li^+ < Be^{2+}$
- Thermal stability of hydrides :
  Group - IA : $LiH > NaH > KH > RbH > CsH$
  Group - IIA : $BeH_2 > MgH_2 > CaH_2 > SrH_2 > BaH_2$
- Order of basic character of hydroxides :
  Group - IA : $CsOH > RbOH > KOH > NaOH > LiOH$
  Group - IIA : $Ba(OH)_2 > Sr(OH)_2 > Ca(OH)_2 > Mg(OH)_2 > Be(OH)_2$
- Thermal stability of metal carbonates :
  Group - IA : $Rb_2CO_3 > K_2CO_3 > Na_2CO_3 > Li_2CO_3$

Group - IIA : $BaCO_3 > SrCO_3 > CaCO_3 > MgCO_3 > BeCO_3$

- Solubility of hydroxides in water :
  Group - IA : $CsOH > RbOH > KOH > NaOH > LiOH$
  Group - IIA : $Ba(OH)_2 > Sr(OH)_2 > Ca(OH)_2 > Mg(OH)_2$
- Hydration energy of Li^+ is maximum. Therefore its conductivity is low.
- **Portland cement :** It is one of the important building material and it is a mixture of $3CaO.Al_2O_3$, $2CaO.SiO_2$ and $3CaO.SiO_2$.
- Mg^{2+} ions are essential for the activation of phosphate transfer enzymes and for the transmission of impulses along nerve fibres.
- Ca^{2+} ions are also important in blood clotting and are required to trigger the contraction of muscles.

Answer Key For Peep Into Previous Years

1.	(a)	2.	(c)	3.	(a)	4.	(c)	5.	(a)	6.	(c)
7.	(a)	8.	(b)	9.	(a)						

EXAM ALERT

National Medical Commission pushes for common entrance test, fee regulation in medical colleges

The government is making concerted efforts to constitute the National Medical Commission (NMC) at the earliest so that some of the major reforms like a common entrance test and regulation of fees can be implemented from the coming academic year 2020-21. According to Health Ministry officials, a common NEET (undergraduate) examination for entry into all medical colleges and also AIIMS, JIPMER, PGI etc will be implemented from 2020. Efforts are being made to notify fee regulations with effect from the year 2020-21 and advance action on this has already been initiated by the Board of Governors of the Medical Council of India.

Health Minister Harsh Vardhan on 4th October assured that the process of implementing the NMC will be done in the most transparent manner and this historic reform of the government will usher in quality and efficient medical education in the country. The Health Ministry has already framed the rules for the constitution of the NMC. The National Medical Commission Act, 2019 was notified in August 2019 to constitute a National Medical Commission for the development and regulation of all aspects relating to medical education, medical profession and medical institutions. It also provides for the constitution of a Medical Advisory Council to advise and make recommendations to the Commission. The Commission will have four autonomous boards, namely Under-Graduate Medical Education Board, Post-Graduate Medical Education Board, Medical Assessment and Rating Board (MARB) and Ethics and Medical Registration Board.

Presently, 23 nominations of Vice-Chancellor and 22 nominations from State Medical Council have been received. Once the MAC is notified, 9 members from State Medical Councils and 10 members from State/UT representatives will be selected as members of the National Medical Commission. The Ministry has already invited applications for the posts of Chairperson of the Commission, Presidents and members of four Autonomous Boards, Members and Secretary of the Commission. The selection to the said posts is to be made on the recommendations of a Search Committee headed by the Cabinet Secretary.

NMC formation will lead to a single entrance exam for admission

Health Ministry officials said the formation of the NMC and simplification of procedures is expected to spur growth in the number of UG and PG seats in the country which will ensure the availability of adequate and qualified medical professionals to cater to the healthcare needs of the country. It will lead to a single entrance examination and common counselling for admission to medical institutions at the UG level including AIIMS.

National Exit Test (NEXT)

A common final year exam, National Exit Test (NEXT) will assess the quality of medical education which would also be the basis for PG entrance and a screening test. The students will not have to appear in a separate exam for PG entrance and may focus on the UG subjects and internship. Indian students getting foreign degrees will have to pass through the same final year exam to get a license.

Separate board to focus on medical education

There will be a separate board to focus on every aspect of the medical education like the development of curriculum, standards of medical education, training of faculty, facilitation of research. The rating of the medical colleges will be done by the Medical Assessment and Rating Board which will encourage colleges to improve the quality of education.

In addition, there will be maintenance of a live register for all registered medical practitioners and a separate register for Community Health Providers. There will be no requirement for annual renewal of the medical colleges.

The NMC will frame guidelines for determination of the fees and all other charges for 50 per cent seats in private medical colleges and deemed universities. As a result, such a proportion of seats in such colleges would be available at a reasonable price. The penal provision for non-compliant colleges would range from warning, monetary penalty, reducing intake, stoppage of admission leading up to withdrawal of recognition. A cadre of Community Health Providers will be created especially for primary and preventive healthcare.

WRAP it up!

1. Which of the following statements is not true about alkali metals?
   (a) Alkali metals do not occur free in nature.
   (b) Alkali metals are good oxidising agents.
   (c) Alkali metal salts impart colour to the flame.
   (d) Alkali metal salts are generally ionic.

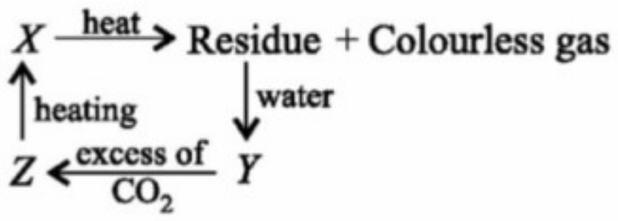
2. Sulphates of Be and Mg are readily soluble in water but sulphates of Ca, Sr and Ba are insoluble. This is due to the fact
   (a) the greater hydration enthalpies of Be^{2+} and Mg^{2+} overcome the lattice enthalpy
   (b) high lattice enthalpy of Be^{2+} and Mg^{2+} makes them soluble in water
   (c) solubility decreases from $BeSO_4$ to $BaSO_4$ due to increase in ionic size
   (d) $BeSO_4$ and $MgSO_4$ are ionic in nature while other sulphates are covalent.

3. Which of the following statements is incorrect ?
   (a) Ordinary water is electrolysed more rapidly than D_2O.
   (b) Reaction between H_2 and Cl_2 is much faster than D_2 and Cl_2.
   (c) D_2O freezes at lower temperature than H_2O.
   (d) Bond dissociation energy for D_2 is greater than H_2.

4. The order of reactivity of halogens towards hydrogen is
   (a) $F_2 > Cl_2 > Br_2 > I_2$ (b) $I_2 > Br_2 > Cl_2 > F_2$
   (c) $Cl_2 > Br_2 > I_2 > F_2$ (d) $Br_2 > Cl_2 > F_2 > I_2$

5. The alkali metals dissolve in ammonia to give a deep blue solution which is conducting in nature.
   $M + (x + y)\ NH_3 \rightarrow [M(NH_3)_x]^+ + e^-(NH_3)_y$
   Which of the following is not true about the solutions of alkali metals in liquid ammonia?
   (a) The blue colour is due to ammoniated electron.
   (b) The solution is paramagnetic.
   (c) In presence of catalyst such as Fe, the blue coloured solutions decompose to form metal imides and nitrogen.
   (d) In concentrated solution blue colour changes to bronze and becomes diamagnetic.

6. Which one of the following pairs of substances will not produce hydrogen when reacted together?
   (a) Copper and conc. nitric acid
   (b) Ethanol and metallic sodium
   (c) Magnesium and steam
   (d) Phenol and metallic sodium

7. 

   Identify *X*, *Y* and *Z*.

	X	*Y*	*Z*
(a)	$Ca(HCO_3)_2$	$CaCO_3$	$Ca(OH)_2$
(b)	$CaCO_3$	$Ca(OH)_2$	$Ca(HCO_3)_2$
(c)	$CaCO_3$	CaO	$Ca(OH)_2$
(d)	$CaCO_3$	CaO	$Ca(HCO_3)_2$

8. Two metals *X* and *Y* belong to the second group of periodic table. *X* forms insoluble oxide but soluble sulphate. *Y* forms a soluble oxide but insoluble sulphate. Hydroxide of metal *X* is soluble in NaOH while that of metal *Y* is insoluble in NaOH. What are metals *X* and *Y*?
   (a) *X* = Be, *Y* = Ba (b) *X* = Ba, *Y* = Ca
   (c) *X* = Ca, *Y* = Sr (d) *X* = Ba, *Y* = Mg

9. Carbon hydrides of the type, C_nH_{2n+2} do not act as Lewis acid or Lewis base. They behave as normal covalent hydrides because
   (a) carbon hydrides are electron-rich hydrides
   (b) carbon hydrides are electron-deficient hydrides
   (c) carbon hydrides are electron-precise hydrides
   (d) carbon hydrides are non-stoichiometric hydrides.

10. In the following chemical equations :
$CaC_2 + A \rightarrow X + Ca(OD)_2$; $SO_3 + D_2O \rightarrow Y$;
$Al_4C_3 + A \rightarrow 3Z + 4Al(OD)_3$
Identify A, X, Y and Z respectively are
(a) D_2O, D_2SO_4, CD_4, C_2D_2
(b) CD_4, C_2D_2, D_2O, D_2SO_4
(c) D_2O, C_2D_2, D_2SO_4, CD_4
(d) C_2D_2, D_2SO_4, D_2O, CD_4

11. On heating a mixture containing 1 mole each of Li_2CO_3 and K_2CO_3 will produce
(a) 2 moles of CO_2 (b) 1 mole of CO_2
(c) 1.5 moles of CO_2 (d) 1 mole of O_2

12. Which gas is produced when calcium nitride (Ca_3N_2) is hydrolysed by water?
(a) N_2 (b) NH_3 (c) H_2 (d) O_2

13. In which of the following reactions H_2O acts as a Bronsted acid?
(a) $H_2O_{(l)} + NH_{3(aq)} \rightleftharpoons OH^-_{(aq)} + NH^+_{4(aq)}$
(b) $H_2O_{(l)} + H_2S_{(aq)} \rightleftharpoons H_3O^+_{(aq)} + HS^-_{(aq)}$
(c) $HCl + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + Cl^-$
(d) $H^+_{(aq)} + OH^-_{(aq)} \rightleftharpoons H_2O_{(l)}$

14. Which of the following does not form double salts?
(a) Li_2SO_4 (b) Na_2SO_4 (c) K_2SO_4 (d) Rb_2SO_4

15. A commercial sample of hydrogen peroxide is labelled as 10 volume. Its percentage strength is nearly
(a) 3% (b) 1% (c) 90% (d) 10%

16. Which of the following statements about alkaline earth metals are correct?
1. Hydration energy of Sr^{2+} is greater than that of Be^{2+}.
2. $CaCO_3$ decomposes at a higher temperature than $BaCO_3$.
3. $Ba(OH)_2$ is a stronger base than $Mg(OH)_2$.
4. $SrSO_4$ is less soluble in water than $CaSO_4$.
(a) Only 4 (b) 1 and 3
(c) 1 and 4 (d) 3 and 4.

17. The oxide which is paramagnetic in nature is
(a) Na_2O_2 (b) CsO_2 (c) Na_2O (d) O_3

18. There are three samples of hydrogen peroxide labelled 10 vol., 15 vol. and 20 vol. Half litre of each was mixed. Calculate volume strength of the new solution.
(a) 7.5 (b) 15.0 (c) 22.5 (d) 51.0

19. Which of the following statements is not correct regarding preparation of NaOH?
(a) NaOH is prepared by electrolysis of sodium chloride in Castner-Kellner cell.
(b) Sodium metal discharged at cathode combines with mercury to form sodium amalgam.
(c) Chlorine is evolved at anode.
(d) Amalgam is heated to separate Na and Hg.

20. Microcosmic salt on heating gives
(a) $NaPO_3 + NH_3 + 5H_2O$
(b) $Na_3PO_3 + NH_3 + 5H_2O$
(c) $NaPO_3 + NH_3 + 4H_2O$
(d) $NaPO_3 + N_2 + 5H_2O$

SOLUTIONS

1. (b) : Alkali metals are good reducing agents.

2. (a) : Due to smaller size their lattice enthalpies are high but their greater hydration enthalpies overcome the lattice enthalpies and they become soluble in water. Ca, Sr and Ba sulphates are insoluble in water due to lower hydration enthalpies.

3. (c) **4. (a)**

5. (c) : In presence of catalyst, it slowly liberates hydrogen resulting in formation of amide.

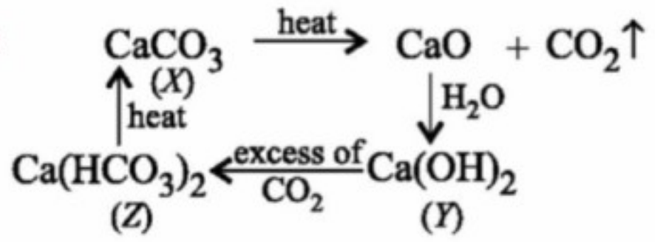
$$\underset{\text{(Blue)}}{M^+_{(am)} + e^-_{(am)}} + NH_{3(l)} \rightarrow \underset{\text{Amide (Brown)}}{MNH_{2(am)}} + \frac{1}{2}H_{2(g)}$$

Where, '*am*' denotes solution in ammonia.

6. (a) : $Cu + 4HNO_3(conc.) \rightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$

$C_2H_5OH + Na \rightarrow C_2H_5O^-Na^+ + 1/2H_2\uparrow$
$Mg + 2H_2O_{(steam)} \rightarrow Mg(OH)_2 + H_2\uparrow$
$C_6H_5OH + Na \rightarrow C_6H_5O^-Na^+ + 1/2H_2\uparrow$

7. (b) :



8. (a) : BeO - Insoluble, $BeSO_4$ - Soluble
BaO - Soluble, $BaSO_4$ - Insoluble
$Be(OH)_2$ - Soluble in NaOH
$Ba(OH)_2$ - Insoluble in NaOH

9. (c) : Carbon hydrides with general formula C_nH_{2n+2} are electron-precise hydrides like CH_4. They have a complete octet hence they do not behave as Lewis acid or Lewis base.

10. (c) : $\underset{(A)}{CaC_2} + 2D_2O \rightarrow \underset{(X)}{C_2D_2} + Ca(OD)_2$

$SO_3 + D_2O \rightarrow \underset{(Y)}{D_2SO_4}$

$\underset{(A)}{Al_4C_3} + 12D_2O \rightarrow \underset{(Z)}{3CD_4} + 4Al(OD)_3$.

11. (b): Li_2CO_3 decomposes while K_2CO_3 is stable and does not decompose.

$$\underset{1\text{ mol}}{Li_2CO_3} \rightarrow Li_2O + \underset{1\text{ mol}}{CO_2}$$

12. (b): $Ca_3N_{2(s)} + 6H_2O_{(l)} \rightarrow 3Ca(OH)_{2(aq)} + 2NH_{3(g)}$

13. (a): H_2O acts as a Bronsted acid and gives a proton to react with a base.

$$\underset{\text{Acid}}{H_2O_{(l)}} + \underset{\text{Base}}{NH_{3(aq)}} \rightleftharpoons OH^-_{(aq)} + NH^+_{4(aq)}$$

In $\underset{\text{base}}{H_2O_{(l)}} + \underset{\text{acid}}{H_2S_{(aq)}} \rightarrow H_3O^+_{(aq)} + HS^-_{(aq)}$, H_2O acts as a Bronsted base with H_2S.

14. (a): Li^+ ion being smallest, Li_2SO_4 does not form double salts, *i.e.*, alums.

15. (a): Volume strength

$$= 5.6 \times \frac{\text{Percentage strength}}{\text{Equivalent weight of } H_2O_2} \times 10$$

$$\text{or, } 10 = \frac{5.6 \times \text{Percentage strength}}{17} \times 10$$

$$\text{or, Percentage strength} = \frac{17}{5.6} = 3.03$$

16. (d): Basic strength of hydroxides increases on going down the group as follows :

$Be(OH)_2 < Mg(OH)_2 < Ca(OH)_2 < Sr(OH)_2 < Ba(OH)_2$

The solubility of the sulphates in water decreases down the group.

$$\underbrace{BeSO_4 > MgSO_4}_{\text{soluble}} > \underbrace{CaSO_4}_{\text{sparingly soluble}} > \underbrace{SrSO_4 > BaSO_4}_{\text{insoluble}}$$

High solubilities of $BeSO_4$ and $MgSO_4$ are due to the high enthalpy of hydration of the smaller Be^{2+} and Mg^{2+} ions, which overcomes the lattice energy factor.

Thermal stability of alkaline earth metal carbonates increases down the group.

17. (b): Superoxides are paramagnetic in nature due to presence of one unpaired electron in π^*2p MO.

18. (b): Normality $= \frac{\text{Volume strength}}{5.6}$

$$N_1 = \frac{10}{5.6}, N_2 = \frac{15}{5.6}, N_3 = \frac{20}{5.6}$$

$$\text{New normality} = \frac{N_1V_1 + N_2V_2 + N_3V_3}{V_1 + V_2 + V_3}$$

$$N = \frac{\left(\frac{10}{5.6} \times 0.5\right) + \left(\frac{15}{5.6} \times 0.5\right) + \left(\frac{20}{5.6} \times 0.5\right)}{0.5 + 0.5 + 0.5}$$

On solving, $N = 15/5.6$

New volume strength $= N \times 5.6 = 15/5.6 \times 5.6 = 15$ vol

19. (d): Amalgam is treated with water to give sodium hydroxide and hydrogen gas.

$2Na$ - amalgam $+ 2H_2O \rightarrow 2NaOH + 2Hg + H_2$

20. (a): $Na(NH_4)HPO_4 \cdot 4H_2O \xrightarrow{\Delta} NaPO_3 + NH_3 + 5H_2O$

THE NOBEL PRIZE IN CHEMISTRY 2019

The Nobel Prize in Chemistry 2019 rewards the development of the lithium-ion battery. This lightweight, rechargeable and powerful battery is now used in everything from mobile phones to laptops and electric vehicles. It can also store significant amounts of energy from solar and wind power, making possible a fossil fuel-free society. The Nobel Prize in Chemistry 2019 was awarded jointly to John B. Goodenough, M. Stanley Whittingham and Akira Yoshino "for the development of lithium-ion batteries." Through their work, they have created the right conditions for a wireless and fossil fuel-free society, and so brought the greatest benefit to humankind.

Akira Yoshino

Born : 1948, Suita, Japan

Affiliation at the time of the award : Asahi Kasei Corporation, Tokyo, Japan, Meijo University, Nagoya, Japan

Prize motivation : "for the development of lithium-ion batteries."

Prize share : 1/3

John B. Goodenough

Born : 1922, Jena, Germany

Affiliation at the time of the award : University of Texas, Austin, TX, USA

Prize motivation : "for the development of lithium-ion batteries."

Prize share : 1/3

M. Stanley Whittingham

Born : 1941, United Kingdom

Affiliation at the time of the award : Binghamton University, State University of New York, New York, NY, USA

Prize motivation : "for the development of lithium-ion batteries."

Prize share : 1/3

MONTHLY TEST DRIVE

This specially designed column enables students to self analyse their extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

Total Marks : 120 **Time Taken : 60 Min.**

The *p*-Block Elements (Group 13 and 14) | Environmental Chemistry

NEET / AIIMS

Only One Option Correct Type

1. The species which is present in solution when CO_2 dissolved in water are
(a) H_2CO_3, CO_3^{2-}
(b) HCO_3^-, CO_3^{2-}
(c) CO_2, H_2CO_3
(d) CO_2, H_2CO_3, HCO_3^-, CO_3^{2-}

2. Identify the wrong statement among the following.
(a) Oxides of nitrogen and sulphur are mainly responsible for acid rain.
(b) Chlorofluorocarbons are responsible for ozone layer depletion.
(c) Greenhouse effect is responsible for global warming.
(d) Ozone layer does not permit infrared radiations from the Sun to reach the Earth.

3. $(A) \xrightarrow{\text{Red hot coke}} CO \xrightarrow{Cl_2} (C) \xrightarrow{H_2O} 2HCl + (A)$.
The compounds (A) and (C) are
(a) CO_2, $COCl_2$ (b) CO, $COCl_2$
(c) C, CO_2 (d) CO_2, CO

4. Which of the following statements is false?
(a) Absorption of the terrestrially radiated heat by the carbon dioxide is the main cause of global warming.
(b) The global warming increases the rate of melting of polar ice caps due to which sea level is increasing.
(c) The global warming of the Earth surface is mainly due to reforestation.
(d) CO_2, N_2O, CH_4, O_3, CCl_4 and water vapours are greenhouse gases.

5. The type(s) of bonds present in diborane is/are
(a) ionic (b) one centred 1 electron bond
(c) covalent and three centred 2 electron bond
(d) covalent and one centred 2 electron bond.

6. The number and type of bonds between two carbon atoms in calcium carbide are respectively
(a) one sigma, one pi (b) one sigma, two pi
(c) two sigma, one pi (d) two sigma, two pi.

7. Which one of the following statements is not true?
(a) pH of drinking water should be in between 5.5 – 9.5.
(b) Concentration of DO below 6 ppm is good for the growth of fishes.
(c) Clean water would have a BOD value of less than 5 ppm.
(d) SO_x, NO_x and CO, are the most widespread air pollutants.

8. Borate salts when heated with conc. H_2SO_4 and C_2H_5OH produce characteristic green colouration on flame due to the formation of volatile compound
(a) $(C_2H_5)_3B$ (b) B_2H_6
(c) $(C_2H_5)_3BO_3$ (d) B_2O_3

9. What is the BOD value of a sewage sample containing 9.2 mg/L of organic matter with the formula $C_6H_{12}O_6$?
(a) 8.625 mg/L (b) 9.2 mg/L
(c) 11.594 mg/L (d) 9.813 mg/L

10. An alkali metal hydride (NaH) reacts with diborane in the presence of *Y* to give a tetrahedral compound, *Z* which is extensively used as reducing agent in organic synthesis. The *Y* and *Z* in the above reaction are
(a) C_2H_6, C_2H_5Na (b) $C_2H_5OC_2H_5$, $NaBH_4$
(c) NH_3, $B_3N_3H_6$ (d) C_3H_8, C_3H_7Na

11. Identify the incorrect statement about orthoboric acids.
(a) It has a layer structure in which planar BO_3 units are joined by hydrogen bonds.
(b) Orthoboric acid, H_3BO_3 is a weak monobasic Lewis acid.
(c) Above 370 K, on heating, orthoboric acid forms metaboric acid and on further heating to red hot, it form boric oxide.
(d) It is estimated by reacting borax with HCl using phenolphthalein as an indicator.

12. Photochemical smog consists of excessive amount of *X*, in addition to aldehydes, acrolein, peroxyacetyl nitrate and so forth. (*X*) is
(a) SO_2 (b) CO (c) O_3 (d) CO_2

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :
(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

13. **Assertion :** Silica is soluble in HF.
Reason : $SiO_2 + 4HF \rightarrow SiF_4 + 2H_2O$
$SiF_4 + 2HF \rightarrow H_2SiF_6$

14. **Assertion :** Manures and biofertilizers should be used in place of chemical fertilizers.
Reason : Chemical fertilizers cause pollution by releasing excess nutrients in water bodies.

15. **Assertion :** Carbon monoxide is extremely toxic.
Reason : Carbon monoxide forms a stable complex with haemoglobin present in red blood cells.

JEE MAIN / ADVANCED

Only One Option Correct Type

16. An organic acid (*A*) reacts with conc. H_2SO_4 to give a neutral oxide (*B*), acidic oxide (*C*) and a diatomic oxide (*D*). When (*D*) reacts with chlorine gas, a poisonous gas (*E*) is evolved. This gas with ammonia gives an organic compound (*F*). The compounds (*A*) and (*F*) are respectively

$$(A) \xrightarrow{\text{conc. } H_2SO_4} H_2O + CO_2 + CO$$

(a) $H_2C_2O_4$ and NH_2CONH_2
(b) CH_3COOH and NH_2CONH_2
(c) $CHCl_3$ and $H_2C_2O_4$
(d) CCl_4 and CH_3CHO

17. Which of the following statements is correct regarding the given reaction?
$B_3N_3H_6$ + Solution of hydrochloric acid $\rightarrow$?
(a) No reaction takes place.
(b) $B_3N_3H_6$ shows substitution reaction and produces $B_3N_3Cl_6$.
(c) $B_3N_3H_6$ shows addition reaction and produces $B_3N_3H_9Cl_3$ in which Cl is bonded to boron.
(d) $B_3N_3H_6$ shows addition reaction and produces $B_3N_3H_9Cl_3$ in which Cl is bonded to nitrogen.

18. Ozone is an important constituent of stratosphere because it
(a) destroys bacteria which are harmful to human life
(b) prevents the formation of smog over large cities
(c) absorbs ultraviolet radiation which is harmful to human life
(d) removes poisonous gases of the atmosphere by reacting with them.

19. The bond dissociation energy of B–F in BF_3 is 646 kJ mol^{-1} whereas that of C–F in CF_4 is 515 kJ mol^{-1}. The correct reason for higher B–F bond dissociation energy as compared to that of C–F is
(a) smaller size of B-atom as compared to that of C-atom
(b) stronger σ-bond between B and F in BF_3 as compared to that between C and F in CF_4
(c) significant $p\pi$-$p\pi$ interaction between B and F in BF_3 whereas there is no possibility of such interaction between C and F in CF_4
(d) lower degree of $p\pi$-$p\pi$ interaction between B and F in BF_3 than that between C and F in CF_4.

More than One Options Correct Type

20. The correct statement(s) for orthoboric acid is/are
(a) it behaves as a weak acid in water due to self ionization
(b) acidity of its aqueous solution increases upon addition of ethylene glycol
(c) it has a three dimensional structure due to hydrogen bonding
(d) it is a weak electrolyte in water.

21. Which of the following statements is/are correct about Al_2Cl_6?
(a) Four Al – Cl bonds are of same length and four of different length.
(b) Six Al – Cl bonds are of same length and two of different length.
(c) The angles of Cl – Al – Cl are 180° and 79°.
(d) The angle of Al – Cl – Al is 101°.

22. If the greenhouse effect or global warming remains unchecked, it alter

(a) CO_2 layer (b) SO_2 layer

(c) O_2 layer (d) O_3 layer.

23. Which of the following statements is/are incorrect regarding the compounds of carbon family?

(a) Maximum coordination number of carbon in commonly occurring compounds is 4, whereas that of silicon is 6.

(b) The stability order of group-14 dihalides is $SiX_2 > GeX_2 > SnX_2 > PbX_2$.

(c) The order of boiling point of hydrides of group-14 elements is $CH_4 < SiH_4 < GeH_4 < SnH_4$.

(d) $MeSiCl_3$ on hydrolysis and subsequent condensation will produce $(Me)Si(OH)_3$.

Numerical Value Type

24. CO is a pollutant produced due to incomplete combustion of butane. One mole of butane requires 6.5 moles of O_2 for complete combustion. If 6 moles of oxygen are available, then number of moles of CO produced will be

25. Anions of chain silicate having formula $(Si_4O_{11})_n^{6n-}$ are formed by sharing how many oxygen atoms by each tetrahedra

26. Total number of substances which contain hexagonal planar rings in their structures graphite, $(BN)_x$, $B_3N_3H_6$, C_6H_6, B_2H_6, Al_2Cl_6 is

Matrix Match Type

Answer the following questions (27 and 28) by appropriately matching the columns based on the information given in the passage :

Any undesirable change in our surroundings that has harmful effects on plants, animals and human beings is called environmental pollution. Any substance which causes pollution is called pollutant. Pollutant can be classified as, primary and secondary pollutant. Pollution always has some source. Pollution of water originates from human activities, through different paths. Easily identified source or place of pollution is called point source. Pollutant also come in solid form like, solid waste detergents, metals chemicals, pieces of clothes, paper, plastics, etc.

Column-I (Pollutants)		Column-II (Sources)	
P.	Microorganisms	I.	Domestic sewage
Q.	Plant nutrients	II.	Chemical fertilizers
R.	Sediments	III.	Erosion of soil by strip mining.
S.	Toxic heavy metals	IV.	Industries and chemical factories

27. Which of the following has the correct combination considering column I and column II ?

(a) P → I (b) R → II (c) Q → IV (d) S → III

28. Which of the following has correct combination considering column I and column II ?

(a) P → III (b) S → IV (c) R → II (d) Q → I

Answer the following questions (29 and 30) by appropriately matching the columns based on the information given in the passage :

Silicates can be considered as metal derivatives of silicic acid, H_4SiO_4 or $Si(OH)_4$. Different silicates may have discrete SiO_4^{4-} tetrahedra or number of such units joined together by sharing of oxygens. Silicates are formed by heating metal oxide or metal carbonates with sand. Silicates are classified into different types on the basis of number of oxygen atoms of SiO_4^{4-} shared with other tetrahedra.

Column-I (Basic unit)		Column-II (Types)	
P.	$(SiO_3)_n^{2n-}$	I.	Pyrosilicate
Q.	$(Si_4O_{11})_n^{6n-}$	II.	Chain silicates
R.	$(Si_2O_5)_n^{2n-}$	III.	Two dimensional sheet silicates
S.	$Si_2O_7^{6-}$	IV.	Cyclic silicate

29. Which of the following has correct combination considering column-I and column-II ?

(a) Q → II (b) P → IV (c) S → III (d) R → I

30. Which of the following has correct combination considering column-I and column-II ?

(a) Q → I (b) R → III (c) S → II (d) P → IV

Keys are published in this issue. Search now! ☺

CHECK YOUR PERFORMANCE

No. of questions attempted .....

No. of questions correct .....

Marks scored in percentage .....

If your score is	
> 80%	Your preparation is going good, keep it up to get high score.
60-80%	Need more practice, try hard to score more next time.
<60%	Stress more on concepts and revise thoroughly.

CBSE warm-up!

CLASS-XI

Chapterwise practice questions for CBSE Exams as per the latest pattern and marking scheme issued by CBSE for the academic session 2019-20.

Series 5 — Hydrogen I The *s*-Block Elements

Time Allowed : 3 hours
Maximum Marks : 70

GENERAL INSTRUCTIONS

(i) All questions are compulsory.
(ii) Section A: Q.no. 1 to 20 are very short answer questions (objective type) and carry 1 mark each.
(iii) Section B: Q.no. 21 to 27 are short answer questions and carry 2 marks each.
(iv) Section C: Q.no. 28 to 34 are long answer questions and carry 3 marks each.
(v) Section D: Q.no. 35 to 37 are also long answer questions and carry 5 marks each.
(vi) There is no overall choice. However an internal choice has been provided in two questions of two marks, two questions of three marks and all the three questions of five marks weightage. You have to attempt only one of the choices in such questions.
(vii) Use log tables if necessary, use of calculators is not allowed.

SECTION - A

Read the given passage and answer the questions 1 to 5 that follow :

Both alkaline earth metals and alkali metals are *s*-block elements. They resemble with each other in many respects but still there are certain dissimilarities in their properties on account of different number of electrons in the valency shell, smaller atomic radii, higher ionisation potential, higher electronegativity, etc.

1. Why are group-2 elements harder than group-1 elements?
2. The melting and boiling points of alkaline earth metals are higher than those of alkali metals. Why?
3. Write any one use of beryllium.
4. Alkaline earth metals give blue colour solutions, when dissolved in liquid ammonia. Why?
5. Compare the alkali metals and alkaline earth metals with respect to ionization enthalpy.

Questions 6 to 10 are one word answers :

6. Name the isotope of hydrogen which is used in nuclear reactor.
7. Which alkali metal ion forms largest hydrated ion in aqueous solution?
8. A metal '*M*' readily forms water soluble sulphate MSO_4, water insoluble hydroxide $M(OH)_2$ and oxide *M*O which is covalent in nature. The hydroxide is soluble in NaOH. Identify the metal *M*.
9. Which isotope of hydrogen is radioactive?

(NCT 2013, 2019)

10. Name the alkaline earth metal hydroxide which is amphoteric.

Questions 11 to 15 are multiple choice questions :

11. Which of the following statement regarding the trend of boiling points of hydrides of N, O and F is correct?

(a) Due to lower molecular masses, NH_3, H_2O and HF have lower boiling points than those of the subsequent group member hydrides.
(b) Due to higher electronegativity of N, O and F, NH_3, H_2O and HF show hydrogen bonding and hence, have higher boiling points than the hydrides of their subsequent group members.
(c) There is no regular trend in the boiling points of hydrides.
(d) Due to higher oxidation states of N, O and F, the boiling points of NH_3, H_2O and HF are higher than the hydrides of their subsequent group members.

12. Chemical '*A*' is used for water softening to remove temporary hardness. '*A*' reacts with sodium carbonate to generate caustic soda. When CO_2 is bubbled through '*A*', it turns cloudy. What is the chemical formula of '*A*'?
(a) $CaCO_3$ (b) CaO
(c) $Ca(OH)_2$ (d) $Ca(HCO_3)_2$

13. Which one of the following statements is incorrect with regard to *ortho* and *para* dihydrogen?
(a) They are nuclear spin isomers.
(b) *Ortho* isomer has zero nuclear spin whereas the *para* isomer has one nuclear spin.
(c) The *para* isomer is favoured at low temperatures.
(d) The thermal conductivity of the *para* and *ortho* isomers are different.

14. The low solubility of LiF in water is due to its ___(i)___. The low solubility of CsI is due to ___(ii)___. LiF is soluble in ___(iii)___ solvents.

	(i)	(ii)	(iii)
(a)	Low lattice enthalpy	Large hydration enthalpy	Polar
(b)	High lattice enthalpy	Smaller hydration enthalpy	Non-polar
(c)	High hydration enthalpy	High lattice enthalpy	Non-polar
(d)	Smaller hydration enthalpy	High lattice enthalpy	Polar

15. 20 mL solution containing 0.2 g of impure sample of H_2O_2 which reacts with 0.316 g of $KMnO_4$ in acidic medium. The purity of H_2O_2 is
(a) 65% (b) 85% (c) 95% (d) 50%

Questions 16 to 20 :
(a) Both assertion and reason are correct statements, and reason is the correct explanation of the assertion.
(b) Both assertion and reason are correct statements, but reason is not the correct explanation of the assertion.
(c) Assertion is correct, but reason is wrong statement.
(d) Assertion is wrong, but reason is correct statement.

16. **Assertion :** The first ionization energy of Be is greater than that of B.
Reason : 2*p*-orbital is lower in energy than 2*s*-orbital.

17. **Assertion :** Temporary hardness can be removed by boiling.
Reason : On boiling, the soluble bicarbonates change to carbonates which being insoluble, get precipitated.

18. **Assertion :** Sodium reacts with oxygen to form Na_2O_2 whereas potassium reacts with oxygen to form KO_2.
Reason : Potassium is more reactive than sodium.

19. **Assertion :** Deuterium is also known as heavy hydrogen.
Reason : Deuterium is a good conductor of heat and electricity.

20. **Assertion :** Superoxides of alkali metals are paramagnetic.
Reason : Superoxides contain O_2^- ion which has one unpaired electron.

SECTION - B

21. **(i)** Hydrogen is relatively inert at room temperature. Explain.
(ii) Why is hydrogen not preferred in balloons?

OR

A sample of water contains 30 ppm of $MgSO_4$ and 19 ppm of $MgCl_2$. Determine the total degree of hardness.

22. Account for the following :
(a) K_2CO_3 cannot be prepared by Solvay process.
(NCERT, NCT 2014, 2016, KVS 2016, 2017)
(b) Beryllium and magnesium do not impart colour to the flame while other members of this group do. Explain.
(NCERT, NCT 2012, 2015, KVS 2016, 2017)

23. 10 mL of a given solution of H_2O_2 contains 0.91 g of H_2O_2. Express its strength in volume.

24. Why on being heated in excess supply of air, K, Rb and Cs form superoxides in preference to oxides and peroxides?

OR

Explain why halides of beryllium fumes in moist air but those of barium do not.

25. How is hydrogen peroxide prepared industrially from 2-ethylanthraquinol?

26. List two properties showing similarity between lithium and magnesium.

27. What happens when :

(i) An alkaline solution of potassium ferricyanide is reacted with H_2O_2.

(ii) Hydrogen peroxide is added to acidified potassium permanganate.

SECTION - C

28. What happens when :

(i) magnesium is burnt in air

(ii) quick lime is heated with silica

(iii) chlorine reacts with slaked lime.

OR

Compare and contrast the chemistry of Group 1 metals with that of group 2 metals with respect to

(i) nature of oxides

(ii) solubility and thermal stability of carbonates

(iii) reactivity and reducing power

29. Hydrogen peroxide acts both as an oxidising and a reducing agent in alkaline solution towards certain first row transition metal ions. Illustrate both these properties of H_2O_2 using chemical equations.

30. When water is added to compound (*A*) of calcium, solution of compound (*B*) is formed. When carbon dioxide is passed into the solution *B*, it turns milky due to the formation of compound (*C*). If excess of carbon dioxide is passed into the solution *C*, milkiness disappears due to the formation of compound (*D*). Identify the compound *A*, *B*, *C* and *D* and also give reactions involved.

OR

Write chemical equations only, involved in the preparation of each of the following :

(i) Plaster of Paris **(ii)** Quick lime

(iii) Slaked lime

Also write any one use of each.

31. (a) Complete and balance the following reaction :

$$MnO_4^-{}_{(aq)} + H_2O_{2(aq)} + H^+_{(aq)} \longrightarrow$$

(b) Compare the structures of H_2O and H_2O_2.

(NCT 2010, 2011)

32. Give reason :

(a) Sodium is less reactive than potassium.

(b) Why do halides and hydrides of Be polymerize?

(c) Sodium is stored under kerosene oil.

33. What is the mass of hydrogen peroxide present in 1 litre of a 2M solution? Calculate the volume of oxygen liberated at STP on the complete decomposition of 100 cm^3 of the above solution.

34. (a) Complete and balance the following reactions :

(i) $LiNO_3 \xrightarrow{Heat}$

(ii) $NaNO_3 \xrightarrow{Heat}$

(b) What are the chief factors responsible for the anomalous behaviour of lithium?

SECTION - D

35. (a) What do you understand by electron- deficient and electron-precise compounds of hydrogen? Provide justification with suitable examples.

(b) Complete the following reactions :

(i) $CaH_2 + H_2O \longrightarrow$

(ii) $NaH + B_2H_6 \xrightarrow{Dry\ ether}$

(iii) $SiCl_4 + LiAlH_4 \xrightarrow{Ether}$

OR

(a) Hydrogen generally forms covalent compounds. Give reason.

(b) Why are the melting and boiling points of D_2O are higher than those of ordinary water?

(c) How does heavy water react with the following :

(i) CaC_2 **(ii)** P_2O_5

(iii) Al_4C_3

36. (a) Starting with sodium chloride how would you proceed to prepare (i) sodium metal, (ii) sodium hydroxide, (iii) sodium peroxide and (iv) sodium carbonate.

(b) Why are group 1 elements called alkali metals?

OR

(a) Identify (*A*), (*B*), (*C*) and (*D*) and give chemical formulae for the following reactions :

$$(A) + NaOH \longrightarrow NaCl + NH_3 + H_2O$$

$$NH_3 + CO_2 + H_2O \longrightarrow (B)$$

$$(B) + NaCl \longrightarrow (C) + NH_4Cl$$

$$(C) \xrightarrow{Heat} Na_2CO_3 + H_2O + (D)$$

(b) Arrange the following in order of property mentioned against each :

(i) $BeCl_2$, $MgCl_2$, $CaCl_2$, $BaCl_2$ (Increasing ionic character)

(ii) $Mg(OH)_2$, $Ca(OH)_2$, $Ba(OH)_2$, $Sr(OH)_2$ (Increasing solubility in water) ***(NCT 2012)***

Quotable Quote

Progress is made by trial and failure; the failures are generally a hundred times more numerous than the successes; yet they are usually left unchronicled.

WILLIAM RAMSAY

37. (a) Calcium burns in nitrogen to produce a white powder which dissolves in sufficient water to produce a gas (*A*) and an alkaline solution. The solution on exposure to air produces a thin solid layer of (*B*) on the surface. Identify the compounds *A* and *B*. Also give all the reactions involved.

(b) It is necessary to add gypsum in the final stages of preparation of cement. Explain why.

OR

(i) Describe the manufacture of caustic soda using the Castner-Kellner process (the mercury cathode cell).

(ii) Draw a neat and labelled diagram of the cell.

(iii) Give three uses of sodium hydroxide.

SOLUTIONS

1. This is because the smaller atomic size causes the electrons to be packed more closely, thereby forming strong metallic bonds.

2. The melting and boiling points of alkaline earth metals are higher than those of alkali metals due to smaller size.

3. Beryllium is used in the manufacture of alloys.

4. The alkaline earth metals dissolve in liquid ammonia to give deep blue black colour solution due to solvated electrons.

$$M + (x+y)NH_3 \rightarrow [M(NH_3)x]^{2+} + 2[e(NH_3)y]^-$$

5. The ionisation energies of alkaline earth elements are higher than those of alkali metals due to higher nuclear charge and smaller radii.

6. Deuterium

7. Lithium ion

8. Beryllium

9. Tritium (^3_1H)

10. Beryllium hydroxide, $Be(OH)_2$

11. (b) : Due to higher electronegativity, the extent of hydrogen bonding in NH_3, H_2O and HF is quite appreciable.

12. (c) : $Ca(OH)_2 + Ca(HCO_3)_2 \longrightarrow 2CaCO_3 + 2H_2O$

$Ca(OH)_2 + Na_2CO_3 \longrightarrow CaCO_3 + 2NaOH$

$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$

13. (b) : *Ortho* isomer has one nuclear spin whereas *para* isomer has zero nuclear spin.

14. (b) : The low solubility of LiF in water is due to its high lattice enthalpy whereas the low solubility of CsI is due to its smaller hydration enthalpy of two large size ions. LiF is soluble in non-polar solvents like ethanol, acetone, etc.

15. (b) : $\because$ Meq of H_2O_2 = Meq of MnO_4^- (in acidic medium)

$$\frac{W_{H_2O_2}}{34/2} \times 1000 = \frac{0.316}{158/5} \times 1000$$

$$W_{H_2O_2} = 0.17 g$$

$\therefore$ 0.2 g of H_2O_2 contains 0.17 g of pure H_2O_2.

Hence, percentage purity $= \frac{0.17}{0.2} \times 100 = 85\%$.

16. (c) : Be has fully filled 2*s*-orbital which gives a relatively more stable electronic configuration.

17. (a) : Temporary hardness is due to presence of bicarbonates of calcium and magnesium which can be removed by boiling.

$$M(HCO_3)_2 \xrightarrow{\Delta} MCO_3 \downarrow + H_2O + CO_2$$

18. (b)

19. (c) : Deuterium is a bad conductor of heat and electricity.

20. (a) : Presence of unpaired electrons in superoxides of alkali metals make them paramagnetic.

21. (i) Hydrogen is relatively inert at room temperature due to its high H—H bond dissociation enthalpy.

(ii) As hydrogen is combustible in nature, it is not preferred in balloons.

OR

Mol. weight of $MgSO_4 = 120$

Now, 120 g of $MgSO_4$ = 100 g of $CaCO_3$

$\therefore$ 30 ppm of $MgSO_4 = \frac{100}{120} \times 30 = 25$ ppm of $CaCO_3$

Mol. weight of $MgCl_2 = 95$

Now, 95 g of $MgCl_2$ = 100 g of $CaCO_3$

$\therefore$ 19 ppm of $MgCl_2 = \frac{100}{95} \times 19 = 20$ ppm of $CaCO_3$

Total amount of $CaCO_3 = 25 + 20 = 45$ ppm

$\therefore$ Total degree of hardness = 45 ppm

22. (a) Unlike $NaHCO_3$ which is sparingly soluble in water, $KHCO_3$ is fairly soluble in water. Thus, when CO_2 gas is passed through an ammoniated brine, $NaHCO_3$ gets precipitated while $KHCO_3$ does not get precipitated when CO_2 is passed through an ammoniated solution of potassium chloride. Hence, K_2CO_3 cannot be prepared by the solvay process.

(b) In Be and Mg, the electrons are tightly held and excitation by mere flame is rather difficult, thus, they do not show flame colouration.

23. 68 g of H_2O_2 produce O_2 = 22400 mL at NTP

$\therefore$ 0.91 g of H_2O_2 will produce $O_2 = \dfrac{22400 \times 0.91}{68}$

$\simeq$ 300 mL at NTP

$\therefore$ Volume strength $\simeq \dfrac{300}{10} = 30$

24. K^+, Rb^+ and Cs^+ are large cations and superoxide ion (O_2^-) is larger than oxide (O^{2-}) and peroxide (O_2^{2-}) ions. Since a large cation stabilizes a large anion, therefore, these metals form superoxides in preference to oxides and peroxides.

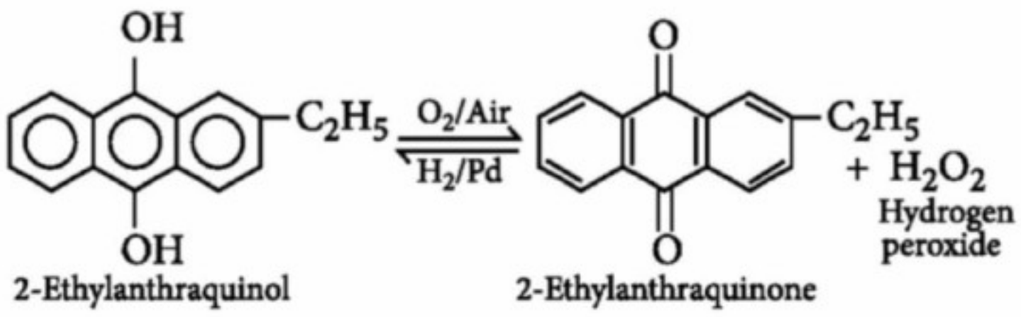
OR

$BeCl_2$ being a salt of a weak base, $Be(OH)_2$ and a strong acid, HCl undergoes hydrolysis by water to form HCl which fumes in air. $BaCl_2$, on the other hand, being a salt of a strong base, $Ba(OH)_2$ and strong acid, HCl does not undergo hydrolysis by water to form HCl and hence does not fumes in air.

$BeCl_2 + 2H_2O \longrightarrow Be(OH)_2 + 2HCl$;

$BaCl_2 + 2H_2O \not\longrightarrow Ba(OH)_2 + 2HCl$

25. On an industrial scale, hydrogen peroxide can be obtained by the auto-oxidation of an organic compound, 2-ethylanthraquinol.



This process is, very cheap and is widely used for the manufacture of hydrogen peroxide.

26. (i) Both lithium and magnesium are harder and lighter than other elements in their respective groups.

(ii) The oxides, Li_2O and MgO do not combine with excess oxygen to give any superoxide.

27. (i) Potassium ferricyanide is reduced to potassium ferrocyanide.

$2K_3Fe(CN)_6 + 2KOH \longrightarrow 2K_4Fe(CN)_6 + H_2O + [O]$

$H_2O_2 + [O] \longrightarrow H_2O + O_2$

$2K_3Fe(CN)_6 + 2KOH + H_2O_2 \longrightarrow 2K_4Fe(CN)_6 + 2H_2O + O_2$

(ii) Potassium permanganate is decolourised due to reduction.

$2KMnO_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 3H_2O + 5[O]$

$[H_2O_2 + [O] \longrightarrow H_2O + O_2] \times 5$

$2KMnO_4 + 3H_2SO_4 + 5H_2O_2 \longrightarrow K_2SO_4 + 2MnSO_4 + 8H_2O + 5O_2$

28. (i) On heating in air, Mg burns with dazzling light, forming magnesium oxide and magnesium nitride.

$2Mg_{(s)} + \underset{\text{(From air)}}{O_{2(g)}} \xrightarrow{\text{Burn}} 2MgO_{(s)}$

$3Mg_{(s)} + \underset{\text{(From air)}}{N_{2(g)}} \xrightarrow{\text{Burn}} Mg_3N_{2(s)}$

(ii) Quick lime when heated with silica forms calcium silicate.

$CaO_{(s)} + SiO_{2(s)} \xrightarrow{\text{Heat}} \underset{\text{Fusible slag}}{CaSiO_{3(s)}}$

(iii) Chlorine reacts with slaked lime to produce bleaching powder.

$\underset{\text{(slaked lime)}}{Ca(OH)_{2(s)}} + Cl_{2(g)} \xrightarrow{\text{Heat}} \underset{\text{Bleaching powder}}{CaOCl_{2(s)}} + H_2O\ (l)$

OR

Property		Group-1 metals	Group-2 metals
(i)	Nature of oxides	Basic. Li forms monoxide, Na forms Na_2O as well as Na_2O_2 (peroxide) K, Rb, Cs form superoxides. Superoxides become more stable as we go down the group.	Except BeO, all other oxides are ionic, BeO is amphoteric. MgO is a weak base. Basicity of oxides increases as we go down the group.
(ii)	Solubility of carbonates Thermal stability of carbonates	Highly soluble in water. Solubility increases down the group Stable. The stability increases down the group.	Sparingly soluble in water. Solubility decreases down the group. Less stable. Thermal stability increases down the group.
(iii)	Reactivity and reducing power	Highly reactive. Very strong reducing agents.	Reactive but less reactive than alkali metals. Fairly strong reducing agents.

29. When H_2O_2 acts as oxidising agent in alkaline medium the reaction that occurs is

$H_2O_2 + 2e^- \longrightarrow 2OH^-$

When H_2O_2 acts as reducing agent in alkaline medium the reaction that occurs is

$H_2O_2 + 2OH^- \longrightarrow O_2 + 2H_2O + 2e^-$

Oxidising character of H_2O_2 in alkaline medium :

$2Cr(OH)_3 + 4NaOH + 3H_2O_2 \rightarrow 2Na_2CrO_4 + 8H_2O$

Reducing character of H_2O_2 in alkaline medium :

$2K_3[Fe(CN)_6] + 2KOH + H_2O_2 \rightarrow 2K_4[Fe(CN)_6] + 2H_2O + O_2$

30. $A = CaO, B = Ca(OH)_2, C = CaCO_3, D = Ca(HCO_3)_2$

$$\underset{(A)}{CaO} + H_2O \longrightarrow \underset{(B)}{Ca(OH)_2}$$

$$\underset{(B)}{Ca(OH)_2} + CO_2 \longrightarrow \underset{\text{Milkiness}}{CaCO_3\downarrow} + H_2O$$

$$\underset{(C)}{CaCO_3} + CO_2 + H_2O \longrightarrow \underset{(D)}{Ca(HCO_3)_2}$$

(Soluble)

OR

(i) Plaster of Paris ($CaSO_4 . \frac{1}{2} H_2O$) :

$$\underset{\text{Gypsum}}{CaSO_4 \cdot 2H_2O} \xrightarrow{373\ K} \underset{\text{Plaster of Paris}}{CaSO_4 \cdot \frac{1}{2} H_2O} + \frac{3}{2} H_2O$$

It is used for immobilising the affected bone during bone fracture or sprain.

(ii) Quick lime (CaO) : $CaCO_3 \overset{\text{Heat}}{\rightleftharpoons} CaO + CO_2$

It is used as primary material for manufacture of cement.

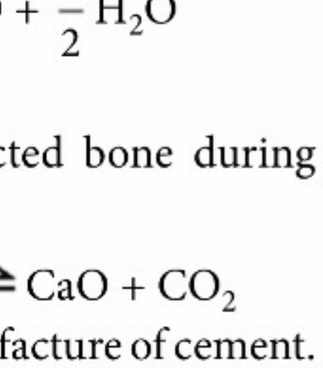
(iii) Slaked lime ($Ca(OH)_2$) : $CaO + H_2O \longrightarrow Ca(OH)_2$

It is used in white wash.

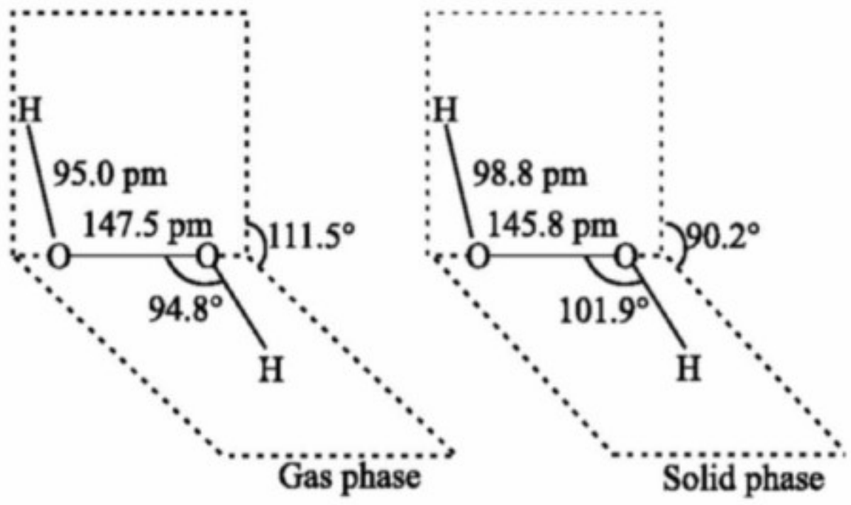
31. (a) $2MnO^-_{4\,(aq)} + 5H_2O_{2(aq)} + 6H^+_{(aq)} \longrightarrow 2Mn^{2+}_{(aq)} + 8H_2O_{(l)} + 5O_{2(g)}$

(b) Structures of H_2O and H_2O_2 :

In H_2O, O is sp^3 hybridised but due to lone pair-lone pair repulsion, the HOH bond angle decreases to 104.5°. Hence, water is a bent molecule.



In H_2O_2, the two oxygen atoms are linked to each other by single bond (peroxide) and each oxygen is further linked to H-atom by single bond. The two O—H bonds are in different plane, giving H_2O_2 a non-planar structure.



32. (a) This is mainly due to high ionisation enthalpy of sodium as compared to potassium. Therefore, potassium is more electropositive, reactive and a stronger reducing agent than sodium.

(b) Since, BeH_2 and $BeCl_2$ have only four electrons in the valence shell, therefore, they are electron-deficient molecules. To make up their electron deficiency, each Be atom forms four three-center two-electron bonds or banana bonds. Thus, BeH_2 and $BeCl_2$ have polymeric structures.

(c) Sodium is stored in kerosene oil because in air, sodium is easily oxidised to sodium oxide which may dissolve in the moisture to form sodium hydroxide.

33. 2M solution of H_2O_2 means 2 mol of H_2O_2 in one litre of the solution.

Molar mass of $H_2O_2 = (2 \times 1 + 2 \times 16)$ g/mol = 34 g/mol

Thus, there are 68 g (= 2 × 34 g) of H_2O_2 in one litre of the solution.

Mass of H_2O_2 in 100 mL of solution $= \frac{68}{1000} \times 100 = 6.8$ g

H_2O_2 decomposes as follows :

$$\underset{\substack{2\text{ mol}\\68\text{ g}}}{2H_2O_2} \longrightarrow 2H_2O + \underset{\substack{1\text{ mol}\\22.4\text{ L}}}{O_2(g)}$$

6.8 g $\qquad \frac{22.4 \times 6.8}{68} = 2.24$ L

Therefore, the volume of oxygen (at STP) liberated from the complete decomposition of 100 mL of 2M H_2O_2 solution is 2.24 L.

34. (a) (i) $4LiNO_3 \xrightarrow{\Delta} 2Li_2O + 4NO_2 + O_2$

(ii) $2NaNO_3 \xrightarrow{\Delta} 2NaNO_2 + O_2$

(b) The chief factors responsible for the anomalous behaviour of lithium are

(i) its very small size,

(ii) high polarizing power,

(iii) high ionization enthalpy and

(iv) absence of vacant *d*-orbital in the valence shell.

35. (a) Electron-deficient and electron–precise hydrides are the types of molecular or covalent hydrides.

Electron–deficient hydrides are those in which the number of electrons are lesser than required for writing the conventional Lewis structures *e.g.*, borane (BH_3).
Electron-precise hydrides have the required number of electrons to write the conventional Lewis structure *e.g.*, methane (CH_4).

(b) (i) $CaH_2 + H_2O \rightarrow Ca(OH)_2 + 2H_2$

(ii) $2NaH + B_2H_6 \xrightarrow{\text{Dry ether}} 2NaBH_4$

(iii) $SiCl_4 + LiAlH_4 \xrightarrow{\text{Ether}} SiH_4 + LiCl + AlCl_3$

OR

(a) Hydrogen can either lose or gain or share one electron to acquire noble gas configuration. But ionisation enthalpy of hydrogen is very high (1312 kJ/mol) and electron gain enthalpy is very low (–73 kJ/mol). As a result, it prefers to form covalent bonds by sharing of electrons.

(b) D_2O has high molecular mass and greater degree of association than H_2O and thus, shows high melting point and boiling point.

(c) (i) $CaC_2 + 2D_2O \longrightarrow C_2D_2 + Ca(OD)_2$

(ii) $P_2O_5 + 3D_2O \longrightarrow 2D_3PO_4$

(iii) $12D_2O + Al_4C_3 \longrightarrow 3CD_4 + 4Al(OD)_3$

36. (a) (i) Sodium metal is prepared by electrolysis of fused NaCl at 873 K using iron cathode and graphite anode (Down's cell).

$NaCl \rightleftharpoons Na^+ + Cl^-$

At anode : $2Cl^- \longrightarrow Cl_2 + 2e^-$

At cathode : $Na^+ + e^- \longrightarrow Na$

(ii) Sodium hydroxide is prepared by electrolysis of aqueous solution of NaCl using Hg cathode and graphite anode. (Castner-Kellner cell).

$NaCl \rightleftharpoons Na^+ + Cl^-$

At cathode : $Na^+ + e^- \xrightarrow{Hg}$ Na-amalgam

At anode : $Cl^- \longrightarrow \frac{1}{2} Cl_2 + e^-$

Na-amalgam is treated with water to give NaOH and H_2.

$2Na\text{-amalgam} + 2H_2O \longrightarrow 2NaOH + 2Hg + H_2$

(iii) Sodium chloride to sodium peroxide :

$NaCl \rightleftharpoons Na^+ + Cl^-$

At anode : $2Cl^- \longrightarrow Cl_2 + 2e^-$

At cathode : $Na^+ + e^- \longrightarrow Na$

Sodium is heated in excess of air.

$2Na + O_2 \xrightarrow{\Delta} Na_2O_2$

(iv) Sodium hydrogen carbonate is prepared by passing CO_2 through NaCl solution saturated with NH_3. $NaHCO_3$ formed is heated to give Na_2CO_3.

$NH_3 + H_2O + CO_2 + NaCl \longrightarrow NaHCO_3 + NH_4Cl$

$2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + H_2O + CO_2$

(b) These are so called because they form hydroxides on reaction with water which are strongly alkaline in nature.

OR

(a) $NH_4Cl + NaOH \longrightarrow NaCl + NH_3 + H_2O$

(*A*)

Thus, '*A*' is ammonium chloride.

$NH_3 + CO_2 + H_2O \longrightarrow NH_4HCO_3$

(*B*)

Thus '*B*' is ammonium bicarbonate.

$NH_4HCO_3 + NaCl \longrightarrow NH_4Cl + NaHCO_3$

(*C*)

Thus '*C*' is sodium bicarbonate.

$2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + H_2O + CO_2$

(*D*)

Thus, '*D*' is carbon dioxide.

(b) (i) $BeCl_2 < MgCl_2 < CaCl_2 < BaCl_2$

(ii) $Mg(OH)_2 < Ca(OH)_2 < Sr(OH)_2 < Ba(OH)_2$

37. (a)

$3Ca + N_2 \longrightarrow Ca_3N_2$

$Ca_3N_2 + 6H_2O \longrightarrow 3Ca(OH)_2 + 2NH_3$

(*A*)

$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$

(*B*)

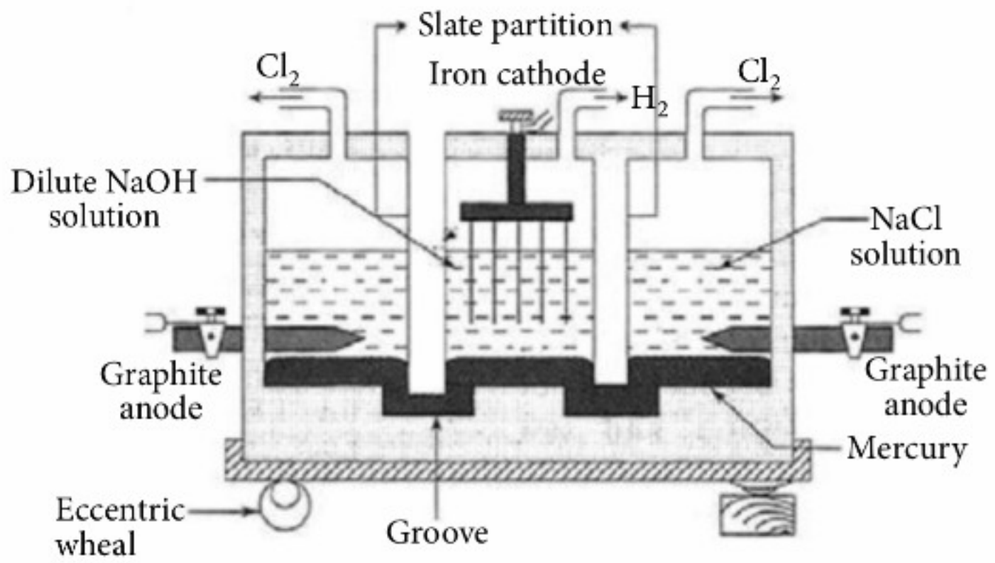
Thus, *A* is NH_3 and *B* is $CaCO_3$

(b) Gypsum ($CaSO_4 \cdot 2H_2O$) is added in the final stages of preparation of cement. This is because when H_2O is added to cement, the process of setting of cement is slowed down by gypsum so that the cement gets sufficiently hardened, thereby imparting greater strength to the cement.

OR

(i) NaOH is manufactured by the electrolyses of aqueous solution of NaCl in a Castner-Kellner cell. The cell consists of an iron tank divided into three compartments with the help of slate partitions which rest in Hg. A number of iron rods dipped in very dilute NaOH solution, placed in the central compartment, act as cathode. The outer compartments contain NaCl solution and two graphite anodes are fixed in these compartments. A mercury layer serves as an intermediate electrode. Mercury is made to move from one compartment to the other by application of rocking motion to the cell with the help of an eccentric wheel.

(ii) Castner-Kellner cell :



In the outer compartments :

$NaCl \rightleftharpoons Na^+ + Cl^-$

At cathode : $Na^+ + e^- \longrightarrow Na$

$Na + Hg \longrightarrow Na/Hg$

At anode : $2Cl^- \longrightarrow Cl_2 + 2e^-$

In the central compartment :

$NaOH \rightleftharpoons Na^+ + OH^-$

At anode : $Na/Hg \longrightarrow Na^+ + Hg + e^-$

At cathode : $2H_2O + 2e^- \longrightarrow 2OH^- + H_2\uparrow$

Thus, Cl_2 is evolved at anode and H_2 at cathode. The concentration of NaOH in the central compartment will go on increasing. When about 20% solution is formed, it is withdrawn and fresh dilute solution of NaOH is added. The further concentration of NaOH can be carried out by evaporation.

(iii) NaOH is used :

(a) in the manufacture of soap, paper, artificial silk,

(b) in the refining of petroleum products,

(c) in the purification of bauxite.

Science Behind Indian Customs

Pronunciation of "OM" and Gayatri Mantra

Pronunciation of "OM" in proper way helps in inhaling maximum oxygen in body which is beneficial for Body and mind. "Om" the core of Indian culture, the sound of universe. Blowing the Conch ("SHANKHAM") is good for lungs and makes them strong. ("SHANKHAM" comes from the two sanskrit words "SHUM" which means "something good" and the "KHAM" meaning "water". Hence the meaning of "SHANKHAM" is "THE CONCH HOLDING THE SACRED WATER").

Gayatri mantra if practiced regularly with proper way can do wonders. Gayatri mantra is a purely scientific thing. The word in the Gayatri mantra produce 24 kinds of vibrations which has effect on the 24 glands of our body.

Why some trees are considered sacred in India?

The two trees (Peepal tree and Audumbar tree) are 24-hour oxygen generators and cannot be planted manually. They grow on their own mainly through the birds, which eat their fruits. Audumbar trees is associated with Guru Dattatreya, one of main Hindu deities and cutting or dishonoring the tree in any way is considered as a sin. Both of these trees are very important for ecological balance. So by associating them with Hindu deities, they have been protected, so that no one would cut them.

The importance of Ganga Jal

We have a great importance of Ganga jal (water from the Ganges river) in Hindu Mythology and devotional practises for purification. It has been determined that, there is a variety of bacteriophages present in waters of the Ganga. Bacteriophages are special variety of viruses, which have capacity to enter their genetic material in the bacterial body, take control, modify functioning and burst it up and multiply at the same time. These bacteriophages cannot infect humans. Thus, the water of the Ganga considered very pure and purifying.

Smearing of cow dung outside households

This is still practised in villages. The cow dung is collected, diluted and smeared in the courtyard which is exposed to the sun. Microbes found in this cow dung are mostly anaerobic and release methane as a byproduct of their oxidation activities. When this methane in the cow dung spread comes in contact with air and sun's heat, it is converted to formaldehyde. Formaldehyde is antimicrobial and germicidal. It even kills spores of bacteria. Thus, providing as a pretty good nature friendly disinfectant.

Methane + O_2 + Sun $\rightarrow$ Formaldehyde

Cow dung has 3-4% of bacteria by mass, so the methane produced is proportionate. The cow dung used is diluted further to produce formaldehyde. As formaldehyde is volatile, therefore it's a daily practise.

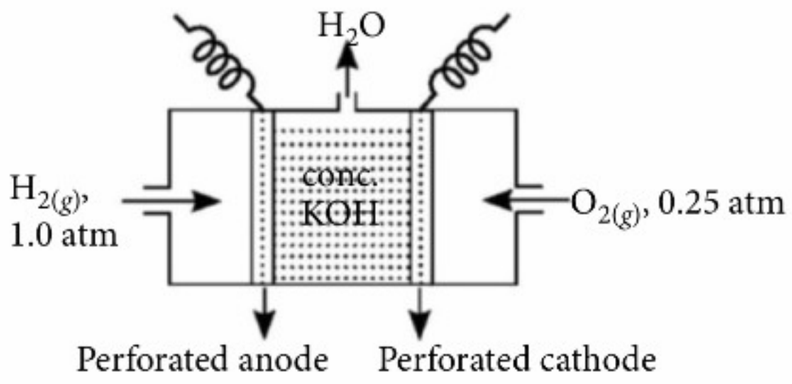
GET SET GO for NEET

Exam on May 3, 2020

with exclusive and brain storming MCQs

Practicing these MCQs help to strengthen your concepts and give you extra edge in your NEET preparation

1. For the given hydrogen-oxygen fuel cell,



$$H_{2(g)} + \frac{1}{2}O_{2(g)} \longrightarrow H_2O_{(l)};\ E^\circ_{cell} = 1.23V$$

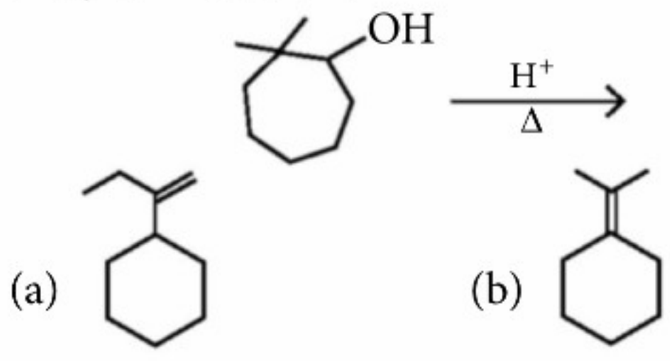
$$\Delta_f H_{H_2O_{(g)}} = -245\ kJ\ mol^{-1}, \Delta_{vap} H_{H_2O_{(l)}} = -40\ kJ\ mol^{-1}$$

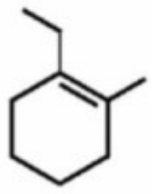
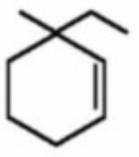
$$\left[\log 2 = 0.3, \frac{2.303RT}{F} = 0.06\right]$$

The efficiency of fuel cell is

(a) 96.08% (b) 41.3% (c) 61.95% (d) 82.68%

2. Which of the following is the major product(s) for the given reaction :



(c)  (d) 

3. The non-stoichiometric compound $Fe_{0.94}O$ is formed when x % of Fe^{2+} ions are replaced by 2/3 Fe^{3+} ions, then x is

(a) 18 (b) 15 (c) 12 (d) 6

4. Which of the following statement is not correct when a mixture of NaCl and $K_2Cr_2O_7$ is gently warmed with concentrated H_2SO_4?

(a) The deep red vapour is evolved.

(b) The vapour when passed into NaOH solution gives a yellow solution of Na_2CrO_4.

(c) Chlorine gas is evolved.

(d) Chromyl chloride is formed.

5. In DNA and RNA, phosphodiester linkages are present between

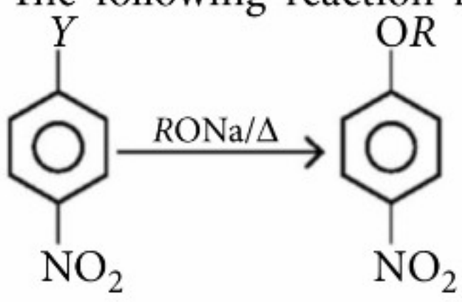
(a) C-3′ of one nucleotide and C-5′ of next nucleotide

(b) C-5′ of one nucleotide and C-4′ of next nucleotide

(c) C-3′ of one nucleotide and C-4′ of next nucleotide

(d) C-1′ of one nucleotide and C-5′ of next nucleotide.

6. The following reaction has maximum rate when

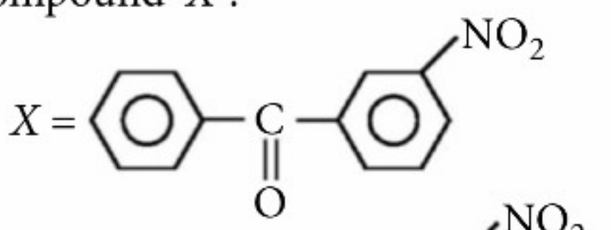


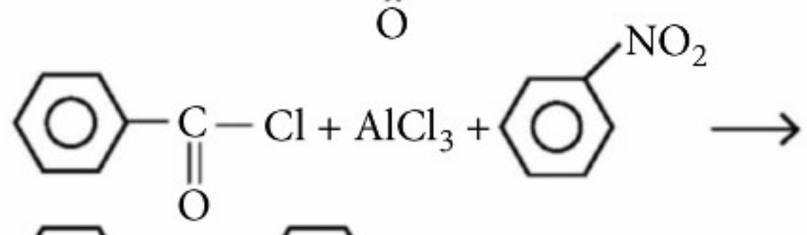
(a) $Y = -I$ (b) $Y = -Br$ (c) $Y = -Cl$ (d) $Y = -F$

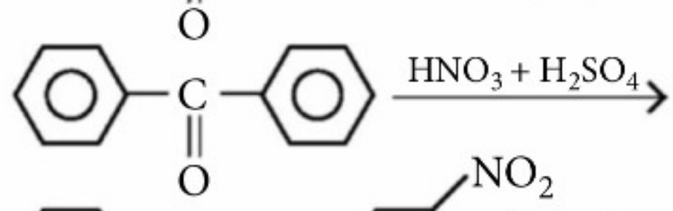
7. Find the strength (in ppm) of decamolal CH_3COOH solution.

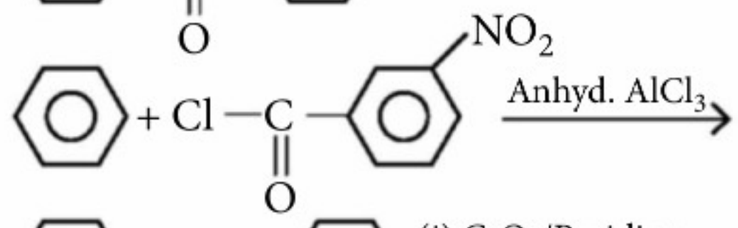
(a) 2×10^5 (b) 3.75×10^5
(c) 1.66×10^6 (d) None of these

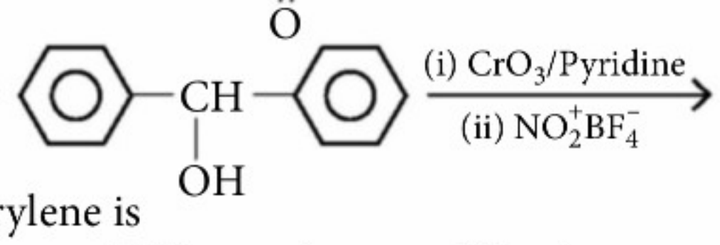
8. Which of the following is not the correct route to prepare compound '*X*'?



(a)


(b)


(c)


(d)


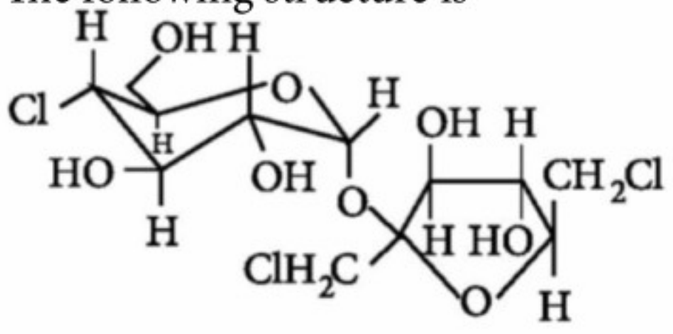
9. Terylene is

(a) an addition polymer with a benzene ring in every repeating unit
(b) a condensation polymer with benzene ring in every repeating unit
(c) an addition polymer with two carbon atoms in every repeating unit
(d) a condensation polymer with two nitrogen atoms in every repeating unit.

10. In the following reaction $A \rightarrow B + C$, rate constant is 0.001 M/sec. If we start with 1M of *A*, the conc. of *A* and *B* after 10 min are respectively

(a) 0.5 M, 0.5 M (b) 0.6 M, 0.4 M
(c) 0.4 M, 0.6 M (d) none of these.

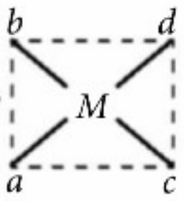
11. The following structure is



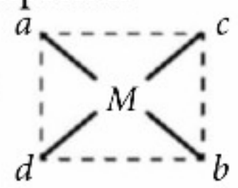
(a) sucrose (b) sucralose
(c) aspartame (d) alitame.

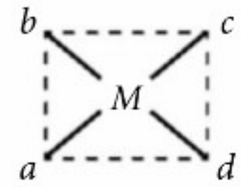
12. The crystal field splitting for Cr^{3+} ion in octahedral field increases for ligands I^-, H_2O, NH_3, CN^- in the order of

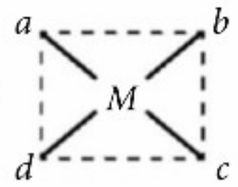
(a) $I^- < H_2O < NH_3 < CN^-$ (b) $CN^- < I^- < H_2O < NH_3$
(c) $CN^- < NH_3 < H_2O < I^-$ (d) $NH_3 < H_2O < I^- < CN^-$

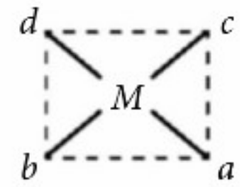
13. $[Mabcd] \xrightarrow[-b]{+a} cis\text{-}[Ma_2cd] \xrightarrow[-a]{+b\ (trans\ to\ c)}$


Incorrect geometrical arrangement of reactant complex is

(a)


(b)


(c)


(d)


14. Select incorrect option for given reaction sequence.

$P_4 + I_2 + H_2O \rightarrow (X) + HI + H_3PO_3$

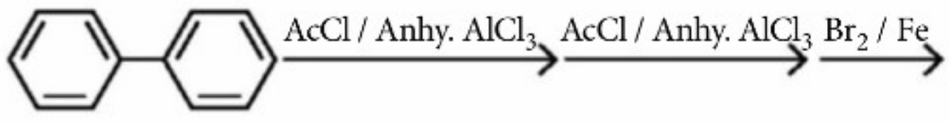
$(X) + KOH_{(aq)} \rightarrow (Y)_{(g)} + (Z)_{(aq)} + H_2O$

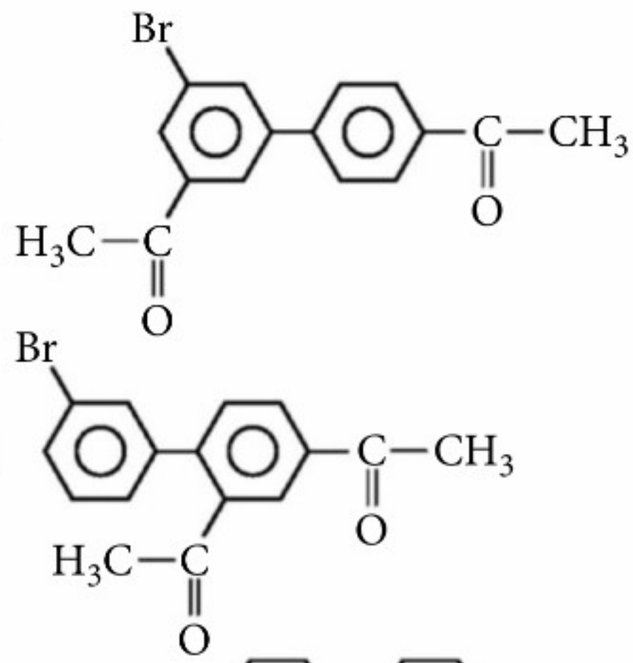
$(Y)_{(g)} \xrightarrow{HgCl_2}$ Black ppt.

$(Z)_{(aq)} \xrightarrow{CuSO_{4(aq)}\ (1\text{-}2\ drop)}$ White ppt.

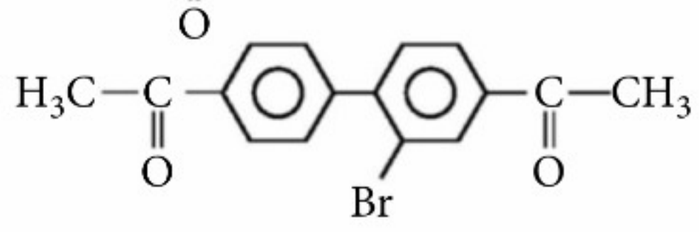
(a) $Y_{(g)}$ produce ppt. with $CuSO_4$.
(b) Reaction of $Z_{(aq)}$ with $CuSO_4$ is a redox reaction.
(c) Bond angle in $P_4 < Y_{(g)}$.
(d) On heating H_3PO_3 it produce $H_4P_2O_7$.

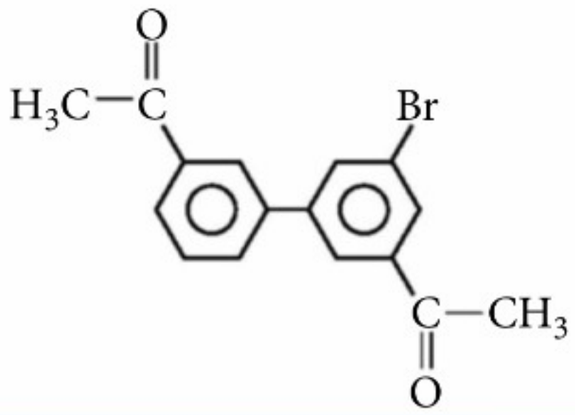
15. The product of the following reaction is



(a)


(b)

(c)


(d) 

SOLUTIONS

1. **(d) :** $E_{cell} = 1.23 - \frac{0.06}{2} \times \log \frac{1}{1 \times (0.25)^{0.5}}$

$E_{cell} = 1.23 - 0.03 \times 0.3 = 1.221\,V$

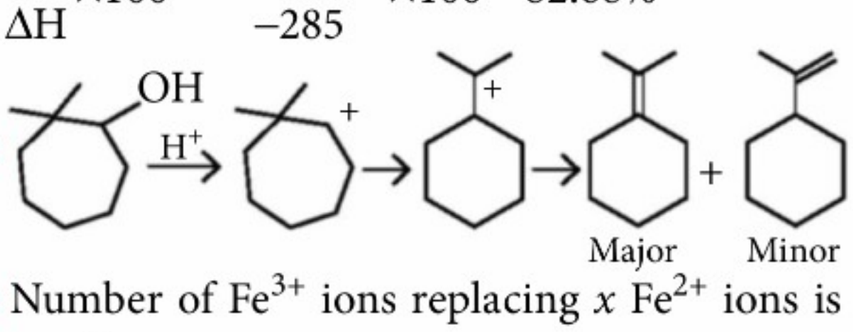
$\Delta G = -2 \times \frac{96500}{1000} \times 1.221 = -235.653\ kJ\ mol^{-1}$

$H_{2(g)} + \frac{1}{2}O_{2(g)} \longrightarrow H_2O_{(g)};\ \Delta_{(f)}H_{(H_2O,g)} = -245\ kJ\ mol^{-1}$

$H_2O_{(g)} \longrightarrow H_2O_{(l)};\ \Delta H_{(H_2O,\,l)} = -40\ kJ\ mol^{-1}$

$H_{2(g)} + \frac{1}{2}O_{2(g)} \longrightarrow H_2O_{(l)};\ \Delta_c H = -285\,kJ\,mol^{-1}$

$\eta = \frac{\Delta G}{\Delta H} \times 100 = \frac{-235.653}{-285} \times 100 = 82.68\%$

2. **(b) :** 

3. **(a) :** Number of Fe^{3+} ions replacing x Fe^{2+} ions is equal to $\frac{2x}{3}$

$\therefore$ Vacancies of cations $= x - \frac{2x}{3} = \frac{x}{3}$

But $\frac{x}{3} = 1 - 0.94 = 0.06$

or $x = 0.06 \times 3 = 0.18$ or 18%

4. **(c) :** Chromyl chloride confirmatory test for ionic chlorides which forms CrO_2Cl_2 (deep red).

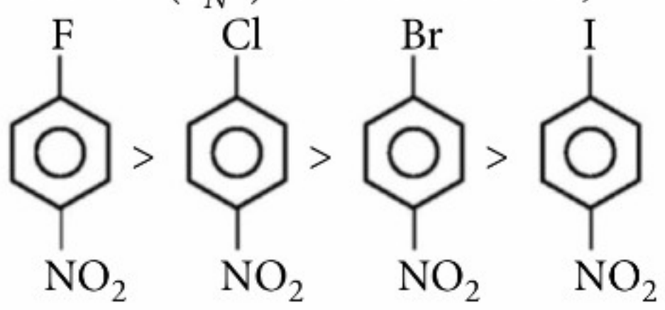
$4NaCl + K_2Cr_2O_7 + 6H_2SO_4 \rightarrow 2CrO_2Cl_2 + 4NaHSO_4 + 2KHSO_4 + 3H_2O$

$CrO_2Cl_2 + 4NaOH \rightarrow \underset{\text{Yellow solution}}{Na_2CrO_4} + NaCl + 2H_2O$

Chromyl chloride

5. **(a)**

6. **(a) :** Rate of Aromatic nucleophilic substitution reaction (S_N2) follows the order,

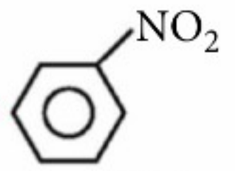


7. **(b) :** Decamolal $CH_3COOH \rightarrow 10$ mol CH_3COOH/kg solvent

Mass of $CH_3COOH = 10 \times 60 = 600$ g

Mass of solution $= 600 + (1\ kg = 1000\ g) = 1600$ g

$\text{Strength(ppm)} = \frac{600}{1600} \times 10^6 = 3.75 \times 10^5$

8. **(a) :**  is highly deactivated due to electron withdrawing nature of NO_2.

9. **(b)**

10. **(c) :** $k = 0.001$ M/sec ($\therefore$ order = zero)

	A	$\rightarrow$	B	+	C
$t = 0$	1 M		0		0
At 't'	$(1 - x)$		x		x

$k = \frac{C_0 - C_t}{t}$

$0.001 = \frac{1 - C_t}{(10\ min = 600\ sec)} \Rightarrow C_t = 1 - 0.6 = 0.4$

$[A] = C_t = 0.4$; $[B] = C_0 - C_t = 0.6$

11. **(b) :** Sucralose is a trichloroderivative of sucrose.

12. **(a) :** Increasing order of ligands strength :

$I^- < H_2O < NH_3 < CN^-$

13. **(a) :** Option (a) is wrong because 'b' in *trans* position *w.r.t.* 'a'.

14. **(d) :** $P_4 + I_2 + H_2O \rightarrow PH_4I + HI + H_3PO_3$

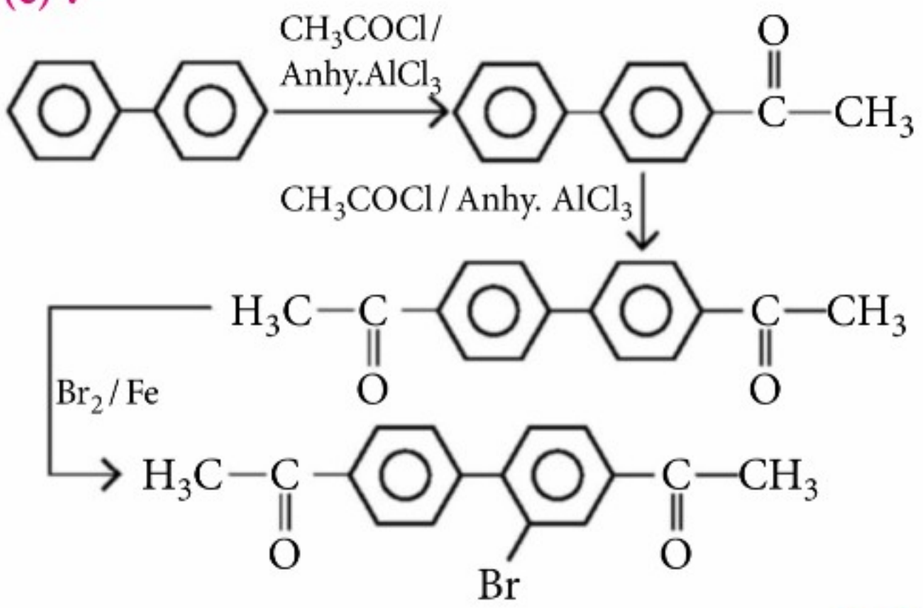
$\underset{(X)}{PH_4I} + KOH_{(aq)} \rightarrow \overset{(X)}{PH_{3(g)}} + KI_{(aq)} + H_2O$

PH_3 (Y): $\xrightarrow{HgCl_2} Hg_3P_2\downarrow$

$KI_{(aq)}$ (Z): $\xrightarrow{CuSO_{4(aq)}\ (1\text{-}2\ drop)} \underset{\text{White ppt.}}{CuI} + I_2 + K_2SO_4$

$3CuSO_4 + 2PH_3 \longrightarrow Cu_3P_2\downarrow + 3H_2SO_4$

$H_3PO_3 \xrightarrow{200^\circ C} 3H_3PO_4 + PH_3$

15. **(c) :** 

BRUSH UP

for

CLASS-XII

NEET/JEE

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2020

Unit 5

Haloalkanes and Haloarenes | Alcohols, Phenols and Ethers

Haloalkanes and Haloarenes

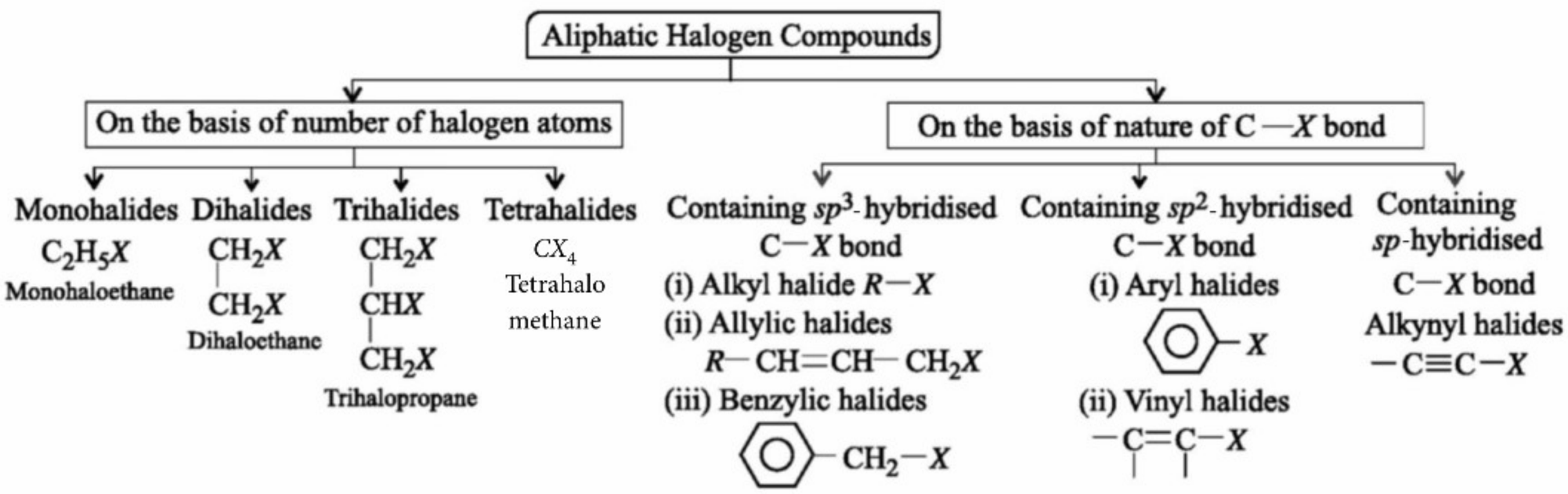
Haloalkanes

- Compounds obtained from alkanes by the replacement of one or more hydrogens by corresponding number of halogen atoms (–F, –Cl, –Br, –I) are termed as *haloalkanes*. *e.g.*, *RX*.

Haloarenes

- When hydrogen atom of the benzene nucleus is substituted by a halogen atom, than haloarenes are formed with general formula C_6H_5X.
- When hydrogen atom of the side chain attached to benzene is substituted by a halogen atom, then aralkyl halide are formed, *e.g.*, benzyl halide ($C_6H_5CH_2X$).

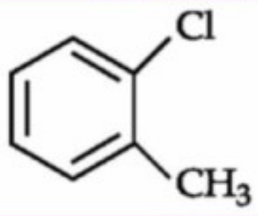
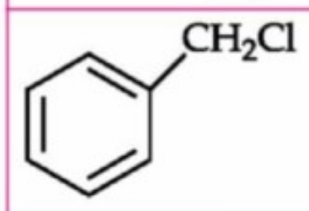
Classification



- **General formula and nomenclature of alkyl/aryl halides :**
  - Monohalogen derivatives - $C_nH_{2n+1}X$ (alkyl halides)
  - Dihalogen derivatives - $C_nH_{2n}X_2$
  - *Geminal dihalides* are formed when both halogens are on the same C-atom.

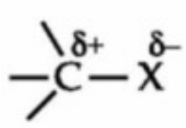
e.g., $CH_3CH(Br)_2$ (ethylidene dibromide)

- *Vicinal dihalides* are formed when both halogens are attached to adjacent carbon atoms, *e.g.*, $ClH_2C - CH_2Cl$
(ethylene dichloride)
- *Terminal dihalides* are formed when halogens are attached to terminal C-atoms of a compound. *e.g.*, $ClH_2C - CH_2 - CH_2 - CH_2Cl$
(tetramethylene dichloride)
- General formula of aryl halides is Ar*X* where Ar = aryl group

Structure	Common name	IUPAC name
$CH_3CH_2CH(Cl)CH_3$	*sec*-Butyl chloride	2-Chlorobutane
$(CH_3)_3CCH_2Br$	*neo*-Pentyl bromide	1-Bromo-2,2-dimethylpropane
	*o*-Chlorotoluene	1-Chloro-2- methylbenzene or 2-Chlorotoluene
	Benzyl chloride	Chlorophenylmethane

Nature of C—*X* bond

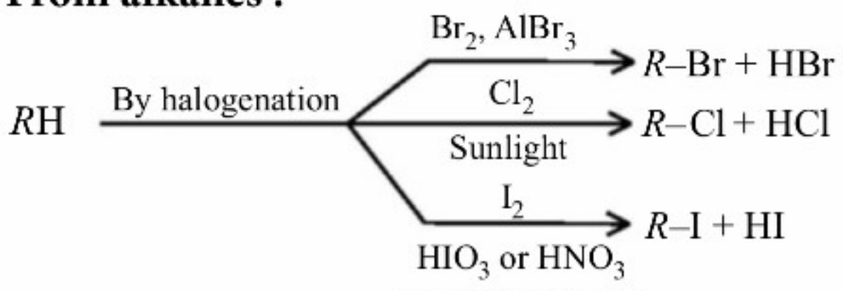
- Since halogen atoms are more electronegative than carbon, the C—*X* bond of an alkyl halide is polarised; the carbon atom bears a partial positive charge whereas the halogen atom bears a partial negative charge.



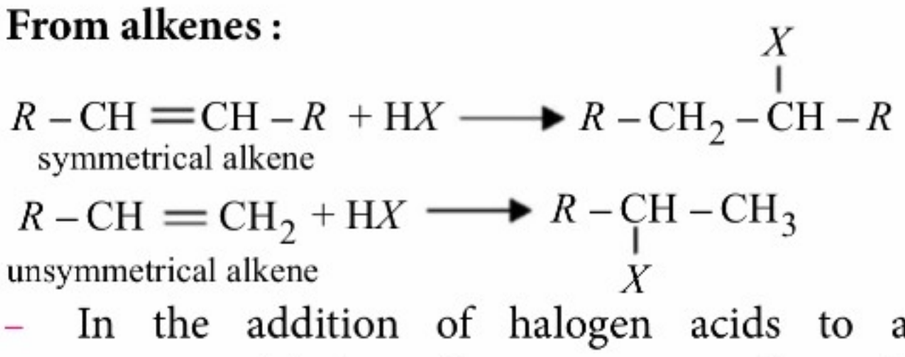
Since the size of halogen atom increases as we go down the group in the periodic table, fluorine atom is the smallest and iodine atom, the largest. Consequently, the carbon-halogen bond length also increases from C—F to C—I and bond enthalpy decreases from C—F to C—I.

General Methods of Preparation of Alkyl Halides

- **From alkanes :**

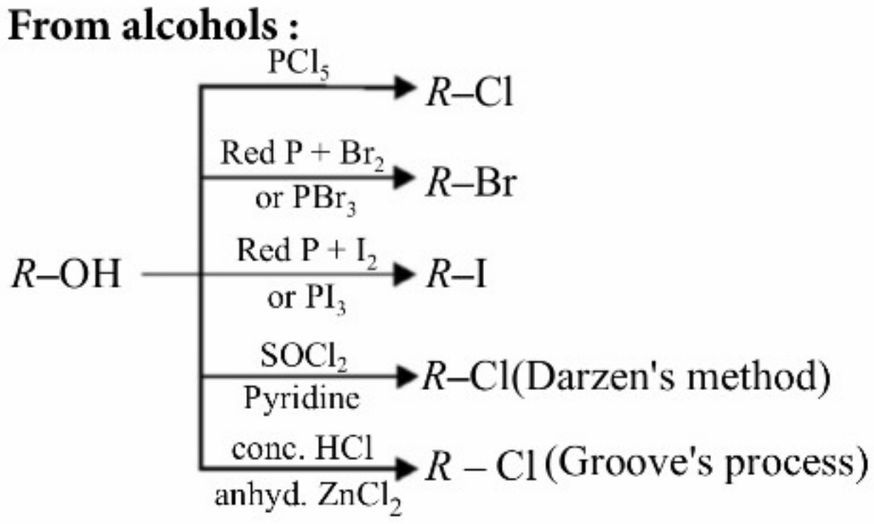


- **From alkenes :**

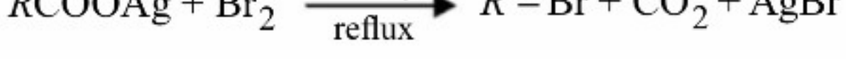


- In the addition of halogen acids to an unsymmetrical alkenes, generally the Markownikoff's rule is followed and the addition occurs through an electrophilic attack. However, in case of reaction with HBr in presence of peroxide, anti-Markownikoff's rule is followed, known as peroxide effect or Kharasch effect.
- The order of reactivity of halogen acids with alkenes is HI > HBr > HCl > HF.

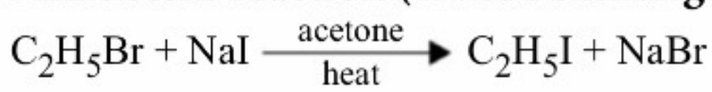
- **From alcohols :**



- **Borodine-Hunsdiecker reaction :**

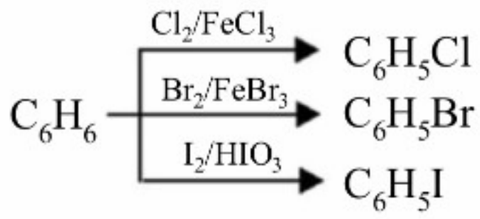


- **Finkelstein reaction (Halide exchange) :**



General Methods of Preparation of Aryl Halides

- **By direct halogenation of benzene :**

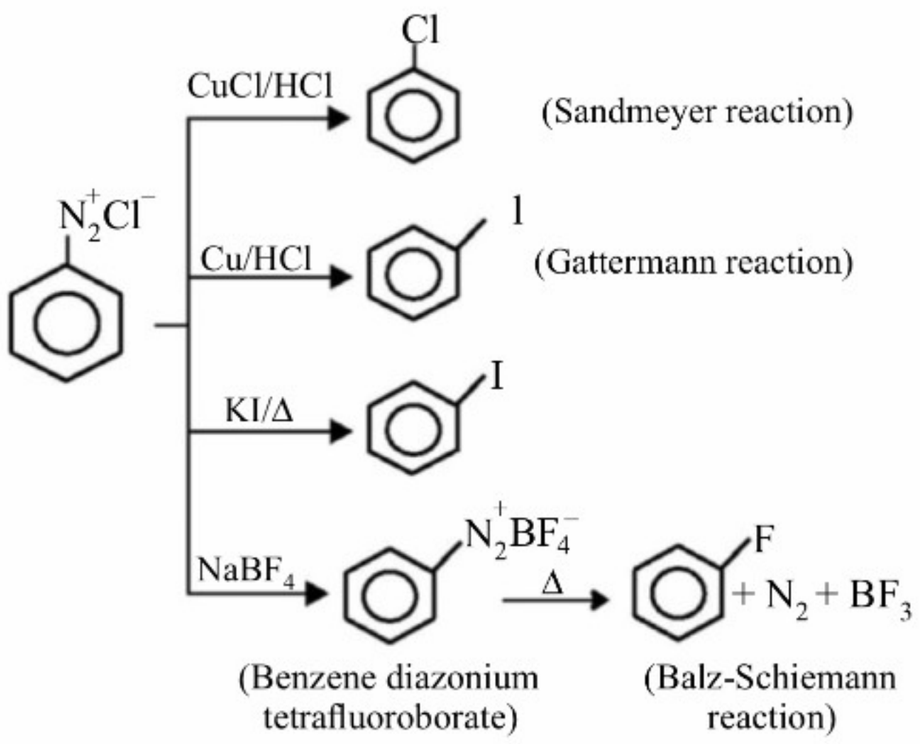


These are electrophilic substitution reaction.

Low temperature and the presence of a halogen carrier favours nuclear substitution. The function of the halogen carrier is to generate the electrophile for the attack.

$$\underset{\text{Lewis acid}}{Cl_2 + FeCl_3} \longrightarrow \underset{\text{Electrophile}}{Cl^+ + FeCl_4^-}$$

- **From benzenediazonium salt :**



- **By Raschig process :**

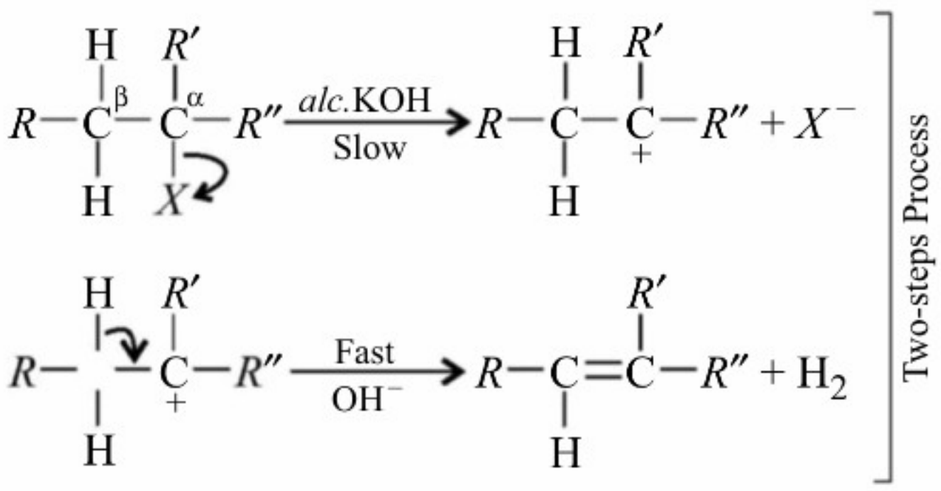
$$2C_6H_6 + 2HCl + O_2 \xrightarrow[500\ K]{CuCl_2} 2C_6H_5Cl + 2H_2O$$

- **By Hunsdiecker reaction :**

$$C_6H_5COOAg + Br_2 \xrightarrow[CCl_4,\ 350\ K]{\text{Distillation}} C_6H_5Br + AgBr + CO_2$$

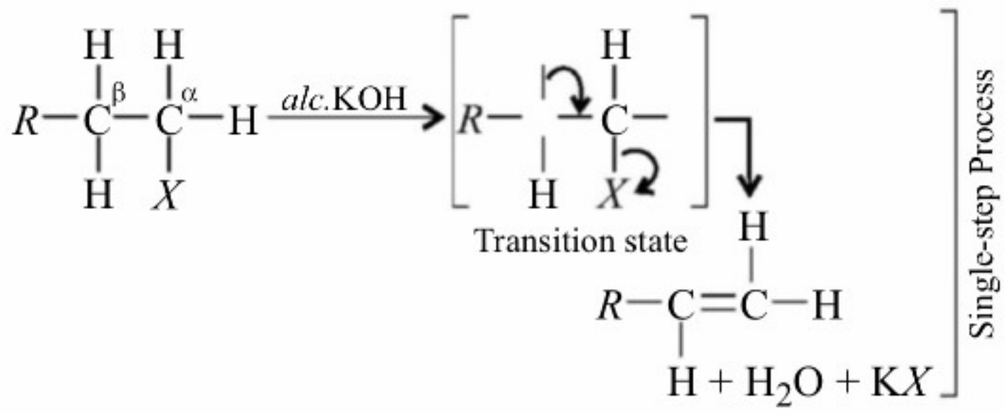
Chemical Properties of Alkyl Halides

- **Elimination reactions :** Alkyl halides undergo β-elimination reaction in the presence of potassium hydroxide in ethanol (high temperature) to yield alkene by E1 or E2 mechanism according to the structure of alkyl halides.
  - **E1 mechanism :**



Rate = k [Alkyl halide]

  - **E2 mechanism :**



Rate = k [Alkyl halide] [base]

In E2, both departing groups H and X must be situated at anti position on adjacent carbon atoms.

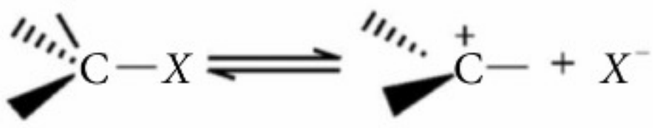
Nucleophilic Substitution Reaction

- **S_N1 Reaction**
  - Substitution nucleophilic unimolecular reactions are abbreviated as S_N1. Consider a general reaction :

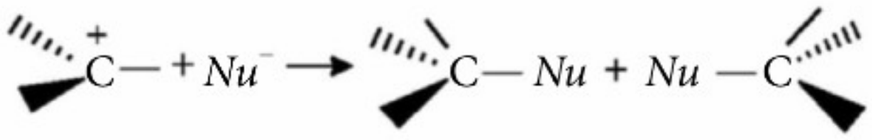
$$R\text{–}X + Nu^- \rightarrow R\text{–}Nu + X^-$$

  - The reaction follows first order kinetics. The rate of reaction is independent of the concentration of nucleophile.
  - The S_N1 mechanism is a two step process, first one being the slow and the rate determining step.

Step - 1



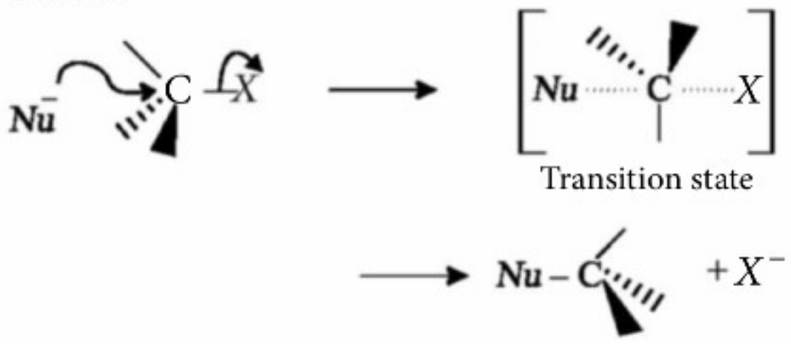
Step - 2



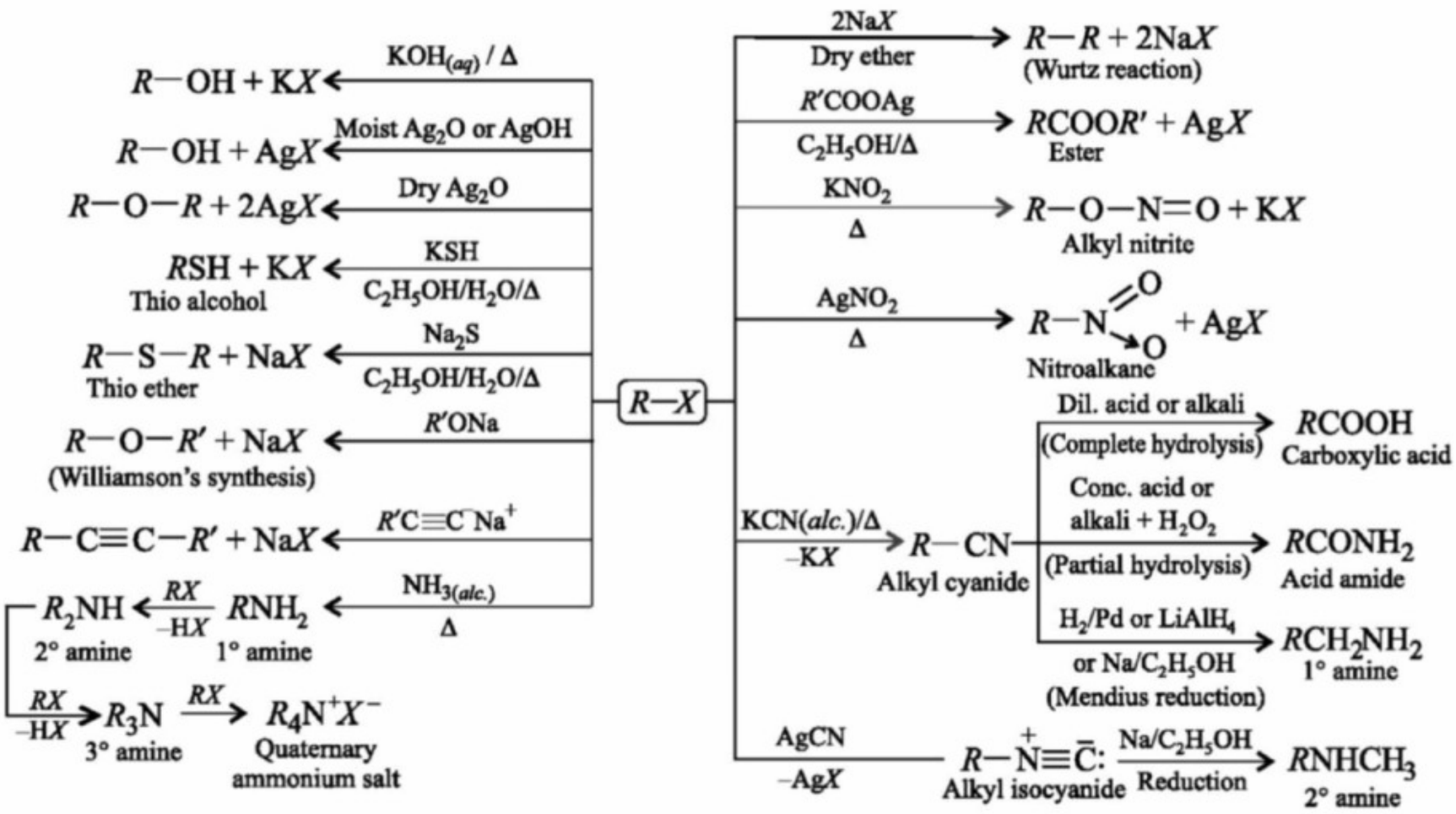
- **S_N2 Reaction**
  - S_N2 mechanism stands for substitution nucleophilic bimolecular. Consider a general reaction :

$$Nu^- + R - X \longrightarrow R - Nu + X^-$$

  - The S_N2 mechanism is a single step process with no intermediate. Bond making and breaking take place simultaneously with the reaction centre.

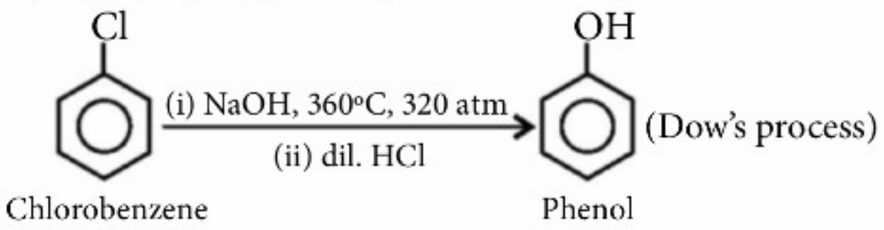


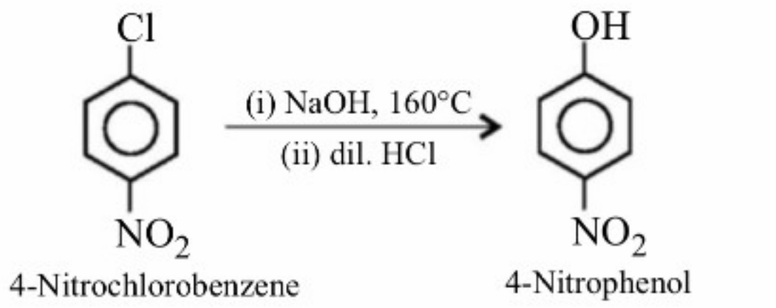
Some Important Nucleophilic Substitution Reactions

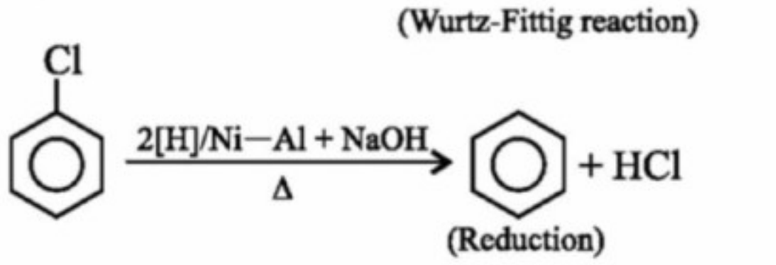


Chemical Properties of Aryl halides

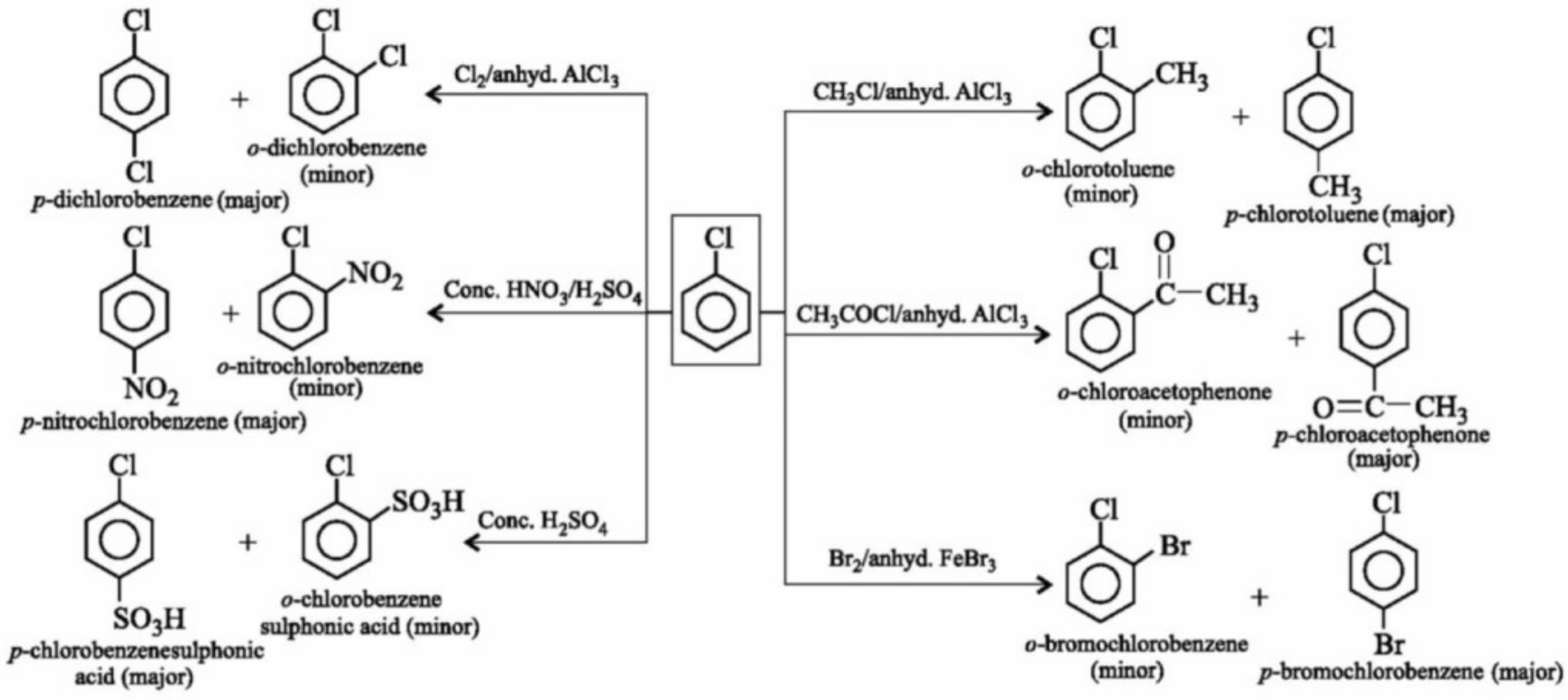
- **Nucleophilic substitution reactions :** Due to resonance effect, haloarenes acquire some double bond character between C—X bond, making them inert towards nucleophile but Cl-atom of chlorobenzene can be replaced by a nucleophile either (i) by placing electron withdrawing group at *ortho* and *para* positions or (ii) by using drastic conditions *i.e.*, by applying high temperature and pressure.







- **Electrophilic substitution reactions :**



CONCEPT MAP

AROMATIC COMPOUNDS

Benzenoids

Aromatic hydrocarbons containing a benzene ring are called benzenoids. Their general formula is C_nH_{2n-6m}, (where, n = no. of C-atoms, m = no. of rings.)

Preparation

Cyclic polymerisation of ethyne

$3CH \equiv CH \xrightarrow[873\ K]{\text{red hot Fe-tube}}$ benzene

Decarboxylation of aromatic acids

$C_6H_5COONa + NaOH \xrightarrow{CaO,\ \Delta} C_6H_6 + Na_2CO_3$

Reduction of phenol

$C_6H_5OH + Zn \xrightarrow{\Delta} C_6H_6 + ZnO$

From chlorobenzene

Chlorobenzene + 2 [H] $\xrightarrow[NaOH]{\text{Ni-Al Alloy}}$ Benzene + 2 HCl

Chlorobenzene $\xrightarrow[\text{Dry ether}]{Mg}$ Phenyl magnesium chloride $\xrightarrow{H_2O}$ Benzene + Mg(OH)Cl

From aniline

Aniline + HNO_2 + HCl $\xrightarrow{273-283\ K}$ Benzene diazonium chloride + $2H_2O$

Benzene diazonium chloride $\xrightarrow[NaOH]{SnCl_2}$ $HCl + N_2$ + benzene

Aromatisation

C_6H_{14} (n-Hexane) $\xrightarrow[773\ K,\ \text{high pressure}]{Cr_2O_3/V_2O_5/Mo_2O_3}$ Benzene + $4H_2$

Formylation

Benzene $\xrightarrow[\text{Anhy. } AlCl_3/\Delta]{CO + HCl}$ Benzaldehyde

(Gattermann–Koch Synthesis)

Properties

Addition reactions

Benzene $\xrightarrow[473-523]{3H_2/\text{Rane}}$ Cyclohexane

Benzene $\xrightarrow[\text{Absence of halogen carrier}]{3Cl_2/h\nu,\ 500\ K}$ Benzene hexachloride

Benzene $\xrightarrow[Zn/H_2O]{O_3}$ Glyoxal + $3H_2O_2$

Electrophilic substitution reactions

Benzene $\xrightarrow[\text{Friedel-Crafts acylation}]{CH_3COCl/\text{Anhy.}AlCl_3}$ Acetophenone

Benzene $\xrightarrow[310-320\ K]{X_2/\text{Anhy.}}$ Halobenzene (X)

Benzene $\xrightarrow[330\ K]{H_2SO_4\ (\text{Fuming})}$ Benzenesulphonic acid

Benzene $\xrightarrow[H_2SO_4(\text{conc.}),\ 323]{HNO_3\ (\text{conc.})}$ Nitrobenzene

Benzene $\xrightarrow[\text{Friedel-Crafts alkylation}]{CH_3Cl//\text{Anhy.}AlCl_3}$ Toluene

Oxidation reactions

$C_6H_6 + 15O_2 \longrightarrow 12CO_2 + 6H_2O$ (Complete oxidation)

Benzene $\xrightarrow[\Delta]{9/2\ O_2/V_2O_5,\ 773\ K}$ Maleic anhydride (Controlled oxidation)

Reduction

Cyclohexane + Methyl Cyclopentane $\xrightarrow{2HI}$ Methylcyclohexane

AROMATIC COMPOUNDS

- Planar, cyclic and completely conjugated
- Contains $(4n + 2)$ π-electrons, (Huckel's Rule) (where, n = an integer)
- If, on ring closure, the π-electron energy of an open chain polyene decreases
  e.g., [6] annulene (Benzene)

Anti-aromatic Compounds

- Planar, cyclic and completely conjugated
- Contains $4n$ π-electrons, (where, n = an integer)
- If, on ring closure, the π-electron energy increases
  e.g., cyclopentadienyl cation

Non-aromatic Compounds

- Non-planar, non-cyclic and not completely conjugated
- If, on ring closure, the π-electron energy remains the same
  e.g., Alkanes, alkenes and 1, 3, 5-cycloheptatriene

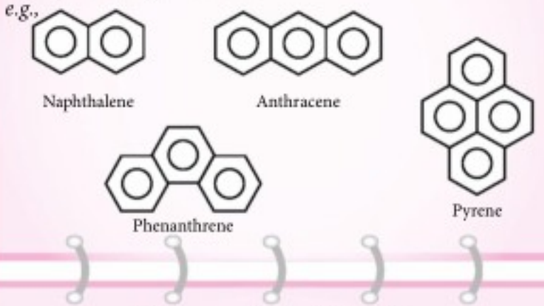
Non-Benzenoids

- Do not contain benzene ring
  e.g., Azulene, tropolone, pyrrole, etc.

Polynuclear Hydrocarbons

Compounds having more than one aromatic ring are known as polynuclear hydrocarbons.

e.g.,

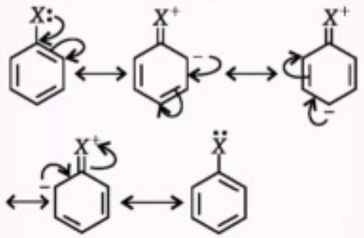


Directive Influence of Substituents

The ability of a group already present in the benzene ring to direct the incoming group to a particular position is called the directive influence of groups.

o, p-directive

Groups with positive mesomeric effect ($+M$) increases electron density at *o*-and *p*-positions due to delocalisation.

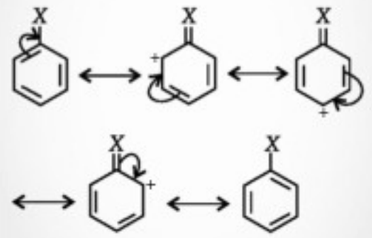


(Here, X may be —CH_3, —C_2H_5, —OCH_3, —NH_2, —NHR, $NHCOCH_3$, —OH, —F, —Cl, —Br, —I.)

Thus, electrophile attacks on *o*- and *p*-positions because these are electron rich positions.

m-directive

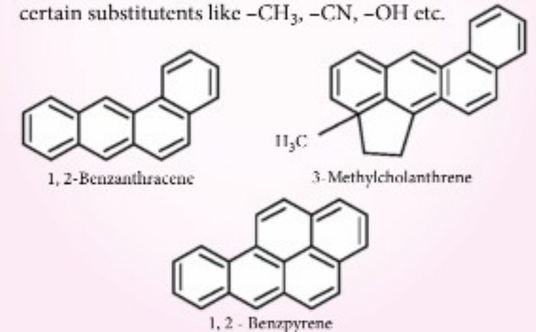
Groups with negative mesomeric effect ($-M$) decreases electron density on *o*- and *p*-positions, so electrophile will attack on *m*-position.



(Here, X may be —NO_2, —CHO, —COR, —COOH, —$COOR$, —SO_3H, —CN.)

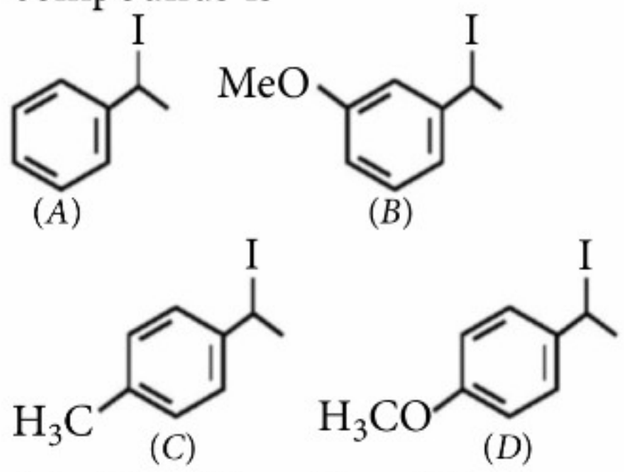
Carcinogenicity & Toxicity

- Radiations, chemicals and physical irritations, coal tar, hormones and certain viruses can be the cause of cancer. The most common out of these is polynuclear hydrocarbons (present in coal tar). Hence, such hydrocarbons are known as carcinogenic polynuclear hydrocarbons.
- These hydrocarbons are mainly formed by incomplete combustion of organic material like coal tar, tobacco, shoot, shale oil and petroleum etc.
- The degree of potency of producing cancerous hydrocarbons varies with the number and position of certain substitutents like $-CH_3$, $-CN$, $-OH$ etc.



Peep Into Previous Years

1. Increasing rate of S_N1 reaction in the following compounds is



(a) (*B*) < (*A*) < (*C*) < (*D*)
(b) (*B*) < (*A*) < (*D*) < (*C*)
(c) (*A*) < (*B*) < (*C*) < (*D*)
(d) (*A*) < (*B*) < (*D*) < (*C*) ***(JEE Main 2019)***

2. The compound C_7H_8 undergoes the following reactions :

$$C_7H_8 \xrightarrow{3Cl_2/\Delta} A \xrightarrow{Br_2/Fe} B \xrightarrow{Zn/HCl} C$$

The product *C* is
(a) *m*-bromotoluene
(b) *o*-bromotoluene
(c) 3-bromo-2,4,6-trichlorotoluene
(d) *p*-bromotoluene. ***(NEET 2018)***

3. The synthesis of alkyl fluorides is best accomplished by
(a) Finkelstein reaction
(b) Swarts reaction
(c) free radical fluorination
(d) Sandmeyer's reaction. ***(JEE Main 2015)***

Basis Concepts about Optical Isomerism

- Optical isomer is known as *dextrorotatory isomer* (latin : *dexter* means right) (*d*-form or +ve) if optically active substance rotates the plane polarised light to the right (clockwise) and *laevorotatory isomer* (latin : *laevo* means left) (*l*-form or –ve) if it rotates the plane polarised light to the left (anticlockwise).
- **Chirality :** The compound is said to have chirality if the central carbon atom is attached to four different groups and this centre is called *chiral* (*asymmetric*) *centre* or *stereogenic centre* or *stereocentre*.
- **Achirality :** The compound is said to have achirality if the central carbon atom have atleast two identical groups and this centre is called *achiral* (*symmetric*).
- If molecule has a plane of symmetry it is *achiral* (*not chiral*) and if molecule has no plane of symmetry it is *chiral*.
- **Enantiomers/*d*- and *l*-isomers :** They are the optical isomers which are non-superimposable mirror images (or dissymmetric).
- An equimolar mixture of the *d*-form and *l*-form will be optically inactive and is called *racemic mixture* (or *dl- form or* (±)*-mixture*).
- The process of conversion of an enantiomer into racemic mixture is known as *racemisation*.
- **Diastereomers :** They are the optical isomers which are not mirror images of each other. They have different physical properties and magnitude of specific rotation.
- **Meso compounds :** These compounds which have two or more even number of chiral carbon atoms and have an internal plane of symmetry. They are optically inactive due to internal compensation.

Polyhalogen Compounds

Carbon compounds containing more than one halogen atom are called polyhalogen compounds.

Uses and environmental effects of some important polyhalogen compounds :

Compounds	Uses	Effects
Chloroform ($CHCl_3$)	– Its major use is in the production of Freon refrigerant, R-22. – It is used as a solvent for resins, rubbers, oils and fats, alkaloids, iodine and many other substances. – It was extensively used as anaesthetic for surgery. – It is used in preparation of chloretone (drug) and chloropicrin (insecticide).	– It is oxidised to poisonous gas, carbonyl chloride, known as *phosgene*. $2CHCl_3 + O_2 \xrightarrow{Light} 2COCl_2 + 2HCl$ Phosgene gas causes liver and kidney damage. – Inhaling chloroform vapours depresses the CNS, causes dizziness, fatigue and headache. – It develop sores when the skin is immersed in chloroform.

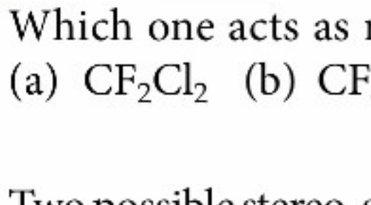
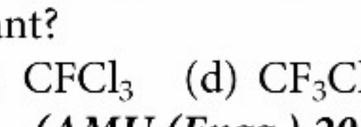
Iodoform (CHI_3)	– It is used as an antiseptic in dressing of wounds due to liberation of iodine. – It is used as methylating agent in organic synthesis.	– It has strong smell due to which, it has, now been replaced by other formulations containing iodine.
Freons	– They are used as refrigerants, blowing agents, propellants in medical applications and degreasing solvent.	– Freons cause disruption of ozone layer by initiating radical chain reactions in stratosphere.
DDT	– Earlier, it was used as a pesticide.	– It is a persistent organic pollutant, strongly absorbed by soil. – It is lipophilic so has a high potential to bioaccumulate.

Peep Into Previous Years

4. Which one acts as refrigerant?
(a) CF_2Cl_2 (b) CF_4 (c) $CFCl_3$ (d) CF_3Cl
(AMU (Engg.) 2018)

5. Two possible stereo-structures of $CH_3CHOHCOOH$, which are optically active, are called
(a) atropisomers (b) enantiomers
(c) mesomers (d) diastereomers.
(NEET 2015)

6. Compound(s) that on hydrogenation produce(s) optically inactive compound(s) is(are)

(a) 
(b) 
(c) 
(d) 

(JEE Advanced 2015)

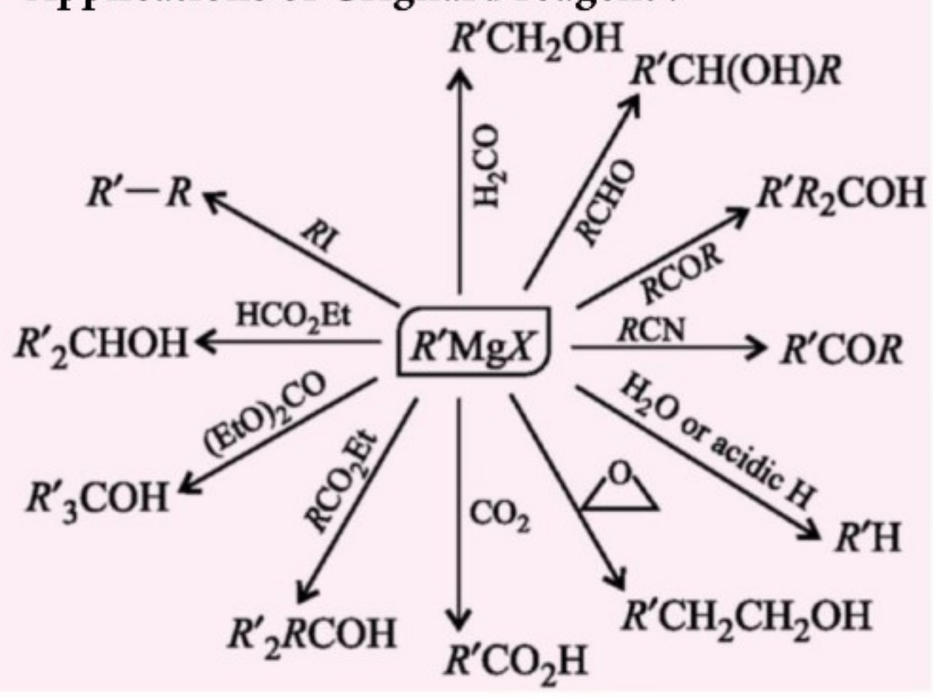
Points For Extra Scoring

➢ **Preparation of Grignard reagent :**

$$RX + Mg \xrightarrow{\text{Dry ether}} RMgX$$

(Grignard reagent)

➢ **Applications of Grignard reagent :**



R' = alkyl, vinyl, aryl
X = Cl, Br, I

Important Conversions

➢ Ascent of series

$$R{-}H \xrightarrow[-HBr]{Br_2/h\upsilon} R{-}Br \xrightarrow[\text{Wurtz reaction}]{\text{Na, dry ether}} R{-}R$$

$$R{-}Br \xrightarrow[-LiBr]{Li/ether} R{-}Li \xrightarrow[-LiI]{CuI} R_2CuLi \xrightarrow[\text{dry ether}]{R'Br} R{-}R'$$

$$ROH \xrightarrow{PBr_3} R{-}Br \xrightarrow[\text{in dry ether}]{Mg} R{-}MgBr \xrightarrow{HCHO} RCH_2OMgBr \xrightarrow{H^+/H_2O} RCH_2OH$$

➢ The reactivity of different types of hydrogens follows the order : benzylic ≈ allylic > tertiary > secondary > primary > vinylic ≈ aryl

➢ A leaving group such as X^-(Cl^-, Br^-, I^- etc.) which leaves with an electron pair is called a *nucleofuge*.

➢ For the same halogen, the order of reactivity of alkyl halides towards S_N1 reactions is 3° > 2° > 1° while for S_N2 reactions the order is 1° > 2° > 3°.

➢ The ease of dehydrohalogenation of alkyl halides follows the order 1° < 2° < 3°.

➢ The presence of electron withdrawing groups like $-NO_2$, $-CN$, $-COOH$, $-CHO$ etc. in *ortho* and *para* positions makes the halogen atom easily replaceable while presence of electron releasing groups like $-NH_2$, $-OH$, $-OR$ etc. decreases the reactivity.

➢ Primary allylic and benzylic halides are more reactive than primary alkyl halides due to the greater stabilisation of allylic and benzylic carbocation intermediate by resonance.

Alcohols, Phenols and Ethers

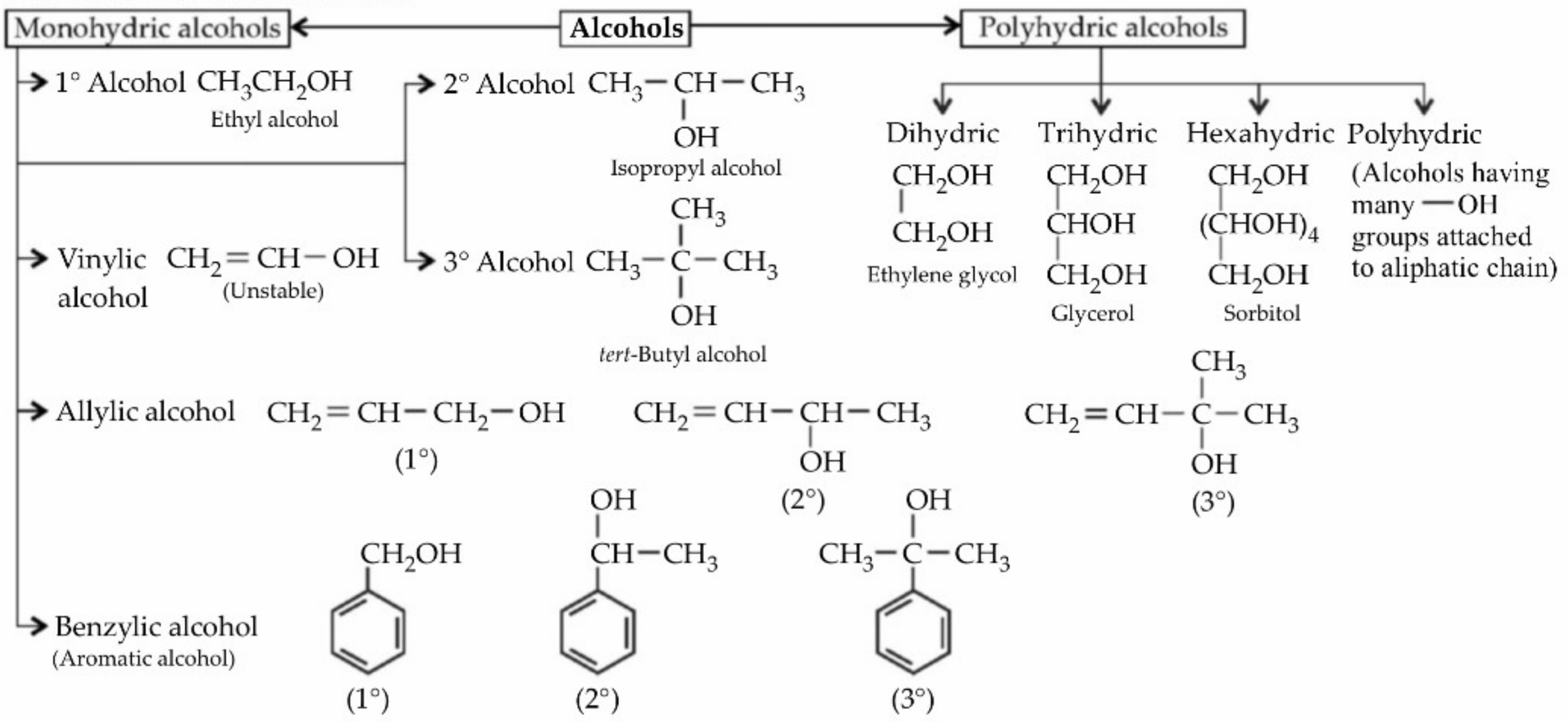
- The compounds obtained by replacing one hydrogen atom from aliphatic hydrocarbons by –OH group are called alcohols whereas those obtained by replacing hydrogen of aromatic hydrocarbons by –OH group are known as phenols. Compounds containing an oxygen atom bonded to two (same/different) alkyl/aryl groups are known as ethers.

General formula

- Alcohol : $C_nH_{2n+1}OH$ $(R - OH)$
- Phenol : C_6H_5OH $(Ar - OH)$
- Ethers : $C_nH_{2n+2}O$ $(R—O—R \text{ or } R—O—R'); n > 1$

Classification

- **Alcohols are classified as :**



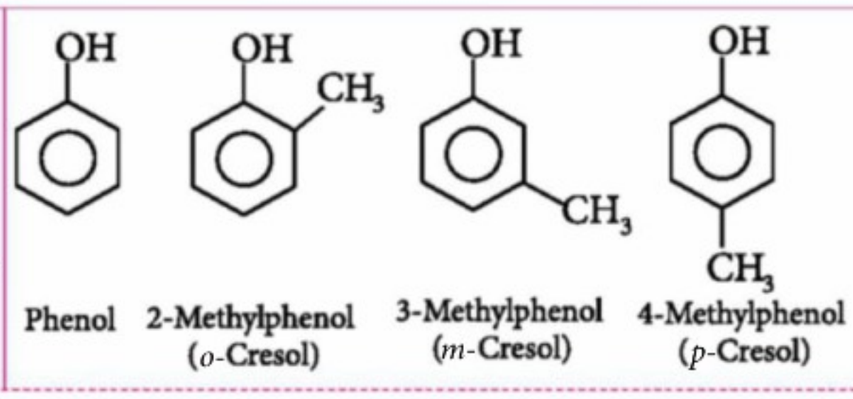
- **Ethers are classified as :**
  - **Aliphatic ethers :**

  e.g., $CH_3 - O - CH_3$, Dimethyl ether (Symmetrical); $CH_3 - O - CH_2CH_3$ Ethyl methyl ether (Unsymmetrical)
  - **Aromatic ethers :**

  e.g., $C_6H_5 - O - CH_3$, Methyl phenyl ether (alkyl aryl ether); $C_6H_5 - O - C_6H_5$ Diphenyl ether (diaryl ether)

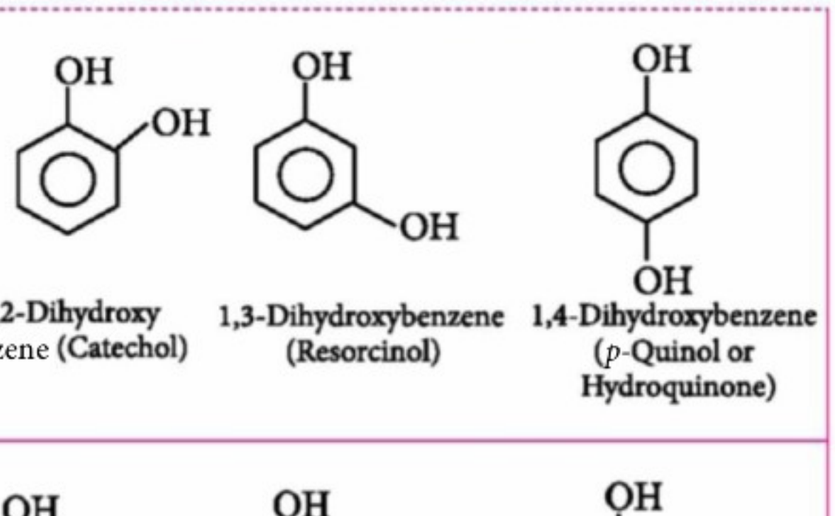
- **Phenols are classified as :**

Monohydric phenols



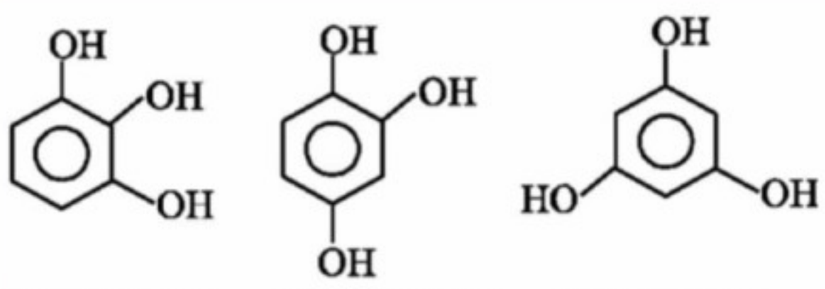
Phenol; 2-Methylphenol (*o*-Cresol); 3-Methylphenol (*m*-Cresol); 4-Methylphenol (*p*-Cresol)

Dihydric phenols



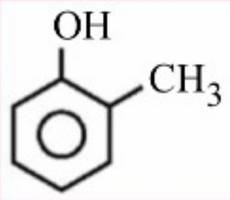
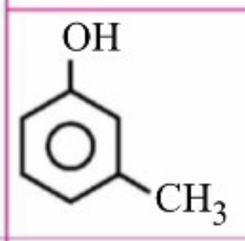
1,2-Dihydroxy benzene (Catechol); 1,3-Dihydroxybenzene (Resorcinol); 1,4-Dihydroxybenzene (*p*-Quinol or Hydroquinone)

Trihydric phenols



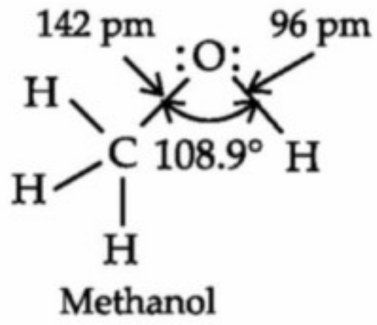
1,2, 3-Trihydroxy benzene (Pyrogallol); 1,2, 4-Trihydroxy benzene (Hydroxyquinol); 1,3, 5-Trihydroxy benzene (Phloroglucinol)

NOMENCLATURE

Class of compounds	Formula	General Name	IUPAC Name
Alcohols	$CH_3CH_2CH_2OH$	*n*-Propyl alcohol	Propan-1-ol
	$CH_3CH(OH)CH_3$	*iso*-Propyl alcohol	Propan-2-ol
Phenols		*o*-Cresol	*o*-Methylphenol
		*m*-Cresol	*m*-Methylphenol
Ethers	$CH_3OC_2H_5$	Ethylmethyl ether	Methoxyethane
	$C_6H_5OCH_3$	Anisole	Methoxybenzene

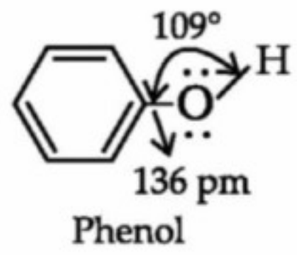
STRUCTURES

- In alcohols, the oxygen of the –OH group is attached to carbon by a sigma (σ) bond which is formed by the overlap of a sp^3-hybridised orbital of carbon with a sp^3-hybridised orbital of oxygen.



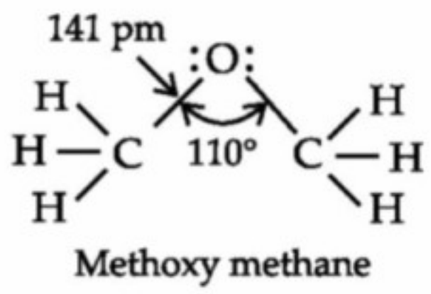
Methanol

- In phenols, the –OH group is attached to sp^2 hybridised carbon of an aromatic ring.



Phenol

- Ethers have a bent structure and are dipolar in nature. The oxygen atom in ethers is sp^3-hybridized.



Methoxy methane

- The C—Ö—H bond angle in alcohols is slightly less then tetrahedral angle 109°28′ due to greater repulsion between lone pair of electrons of oxygen.

ALCOHOLS

Methods of Preparation

Hydration of alkenes $RCH{=}CH_2 \xrightarrow[\text{(Hydration)}]{H_2O/H^+}$	A
Hydroboration oxidation $RCH{=}CH_2 \xrightarrow{B_2H_6/H_2O_2,\ OH^-}$	L
Oxymercuration reduction $RCH{=}CH_2 \xrightarrow[(ii)\ NaBH_4]{(i)\ Hg(OAc)_2;\ H_2O}$	C
From Grignard reagent $>C{=}O \xrightarrow[(ii)\ H^+/H_2O]{(i)\ RMgX}$	O
From aliphatic primary amines $RNH_2 + HONO \longrightarrow$	H
From haloalkanes $R{-}X + KOH_{(aq)} \longrightarrow$	O
From carbonyl compounds $RCHO \xrightarrow[\text{or } LiAlH_4]{H_2/Ni}$	
$R_2C{=}O \xrightarrow{H_2/Ni}$	L
$RCOOH \xrightarrow{LiAlH_4}$	
$RCOOR' \xrightarrow{LiAlH_4}$	
$RCOOR' \xrightarrow{Na/C_2H_5OH}$	S

Chemical Properties

A

$$ROH \xrightarrow{Na} RONa + H_2$$

$$ROH \xrightarrow{R'COOH} R'COOR + H_2O$$

L

$$ROH \xrightarrow{RCOCl} RCOOR + HCl$$

$$ROH \xrightarrow{(RCO)_2O} RCOOR + RCOOH$$

C

$$ROH \xrightarrow{R'MgX} R'H + Mg(OR)X$$

$$ROH \xrightarrow{HX} RX + H_2O$$

O

$$ROH \xrightarrow{PX_3} RX + H_2O$$

$$ROH \xrightarrow{PCl_5} RCl + POCl_3 + HCl$$

H

$$ROH \xrightarrow{SOCl_2} RCl + SO_2 + HCl$$

$$ROH \xrightarrow[443\ K]{Conc.\ H_2SO_4} RCH{=}CH_2 + H_2O$$

O

$$ROH \xrightarrow[413\ K]{Conc.\ H_2SO_4} ROR + H_2O$$

L

$$ROH \xrightarrow[\text{or } KMnO_4/OH^-]{K_2Cr_2O_7/H^+} R{-}COOH$$

$$ROH \xrightarrow[-H_2]{Cu/573\ K} \underset{\text{(from 1° alcohol)}}{RCHO} \text{ or } \underset{\text{(from 2° alcohol)}}{RCOR} \text{ or } \underset{\text{(from 3° alcohol)}}{\text{alkene}}$$

S

$$ROH \xrightarrow[\text{or } CrO_3\cdot C_5H_5N\cdot HCl]{PCC} RCHO$$

Peep Into Previous Years

7. When vapours of a secondary alcohol is passed over heated copper at 573 K, the product formed is
(a) a carboxylic acid (b) an aldehyde
(c) a ketone (d) an alkene.
(Odisha NEET 2019)

8. The number of alkene(s) which can produce 2-butanol by the successive treatment of (i) B_2H_6 in tetrahydrofuran solvent and (ii) alkaline H_2O_2 solution is
(a) 1 (b) 2
(c) 3 (d) 4 ***(WB JEE 2018)***

9. Which of the following reaction(s) can be used for the preparation of alkyl halides?

(I) $CH_3CH_2OH + HCl \xrightarrow{anh.\ ZnCl_2}$

(II) $CH_3CH_2OH + HCl \longrightarrow$

(III) $(CH_3)_3COH + HCl \longrightarrow$

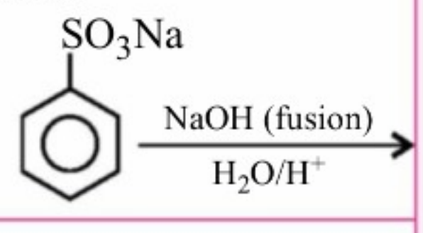
(IV) $(CH_3)_2CHOH + HCl \xrightarrow{anh.\ ZnCl_2}$

(a) (I) and (II) only (b) (IV) only
(c) (III) and (IV) only
(d) (I), (III) and (IV) only ***(AIPMT 2017)***

Phenols

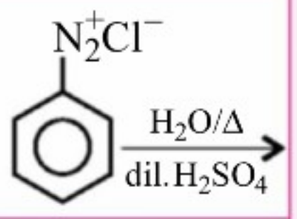
Methods of Preparation

From benzene sulphonic acid



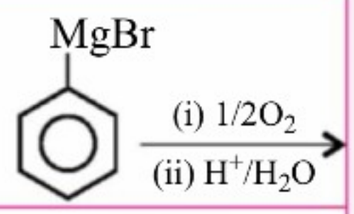
P

From diazonium salts



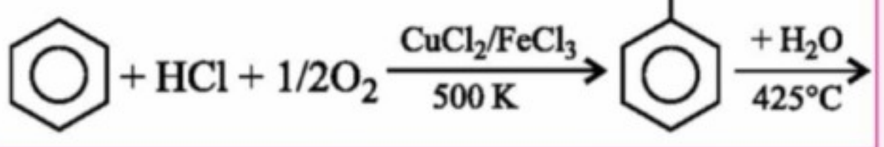
H

From Grignard reagent



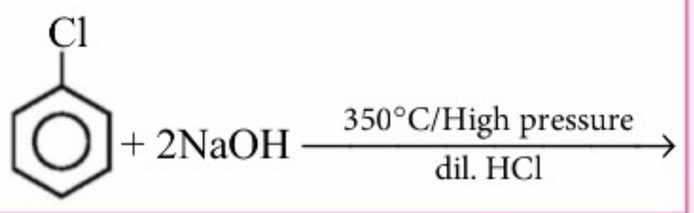
E

Raschig's process



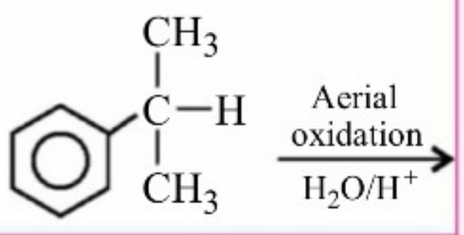
N

Dow's process



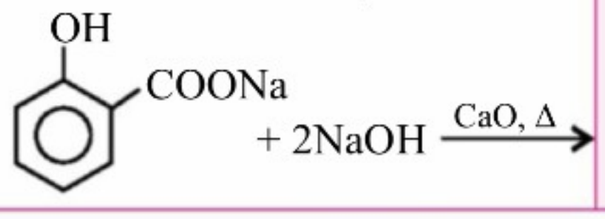
O

From cumene



L

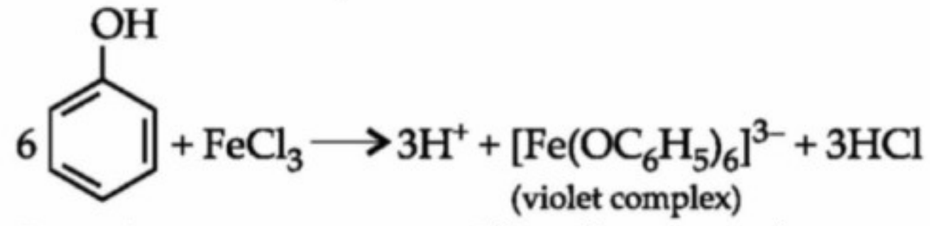
By decarboxylation of sodium salicylate



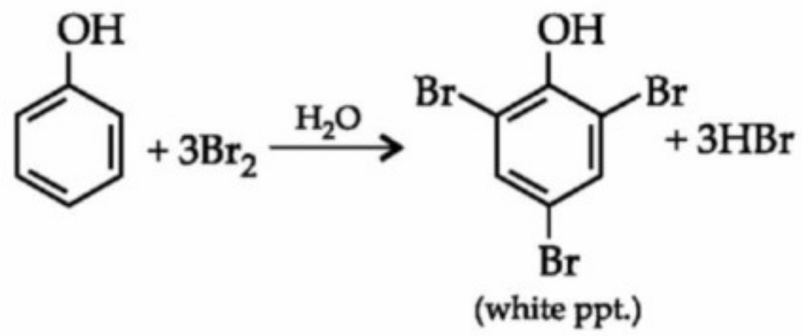
S

Test for Phenols

- **Ferric chloride test :** Phenol gives violet colour with neutral $FeCl_3$ solution.

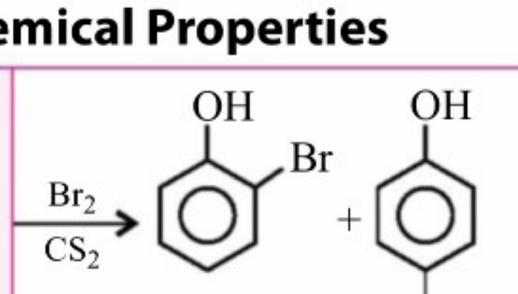


- **Bromine water test :** Phenol gives white ppt. with Br_2-water due to the formation of 2, 4, 6-tribromophenol.

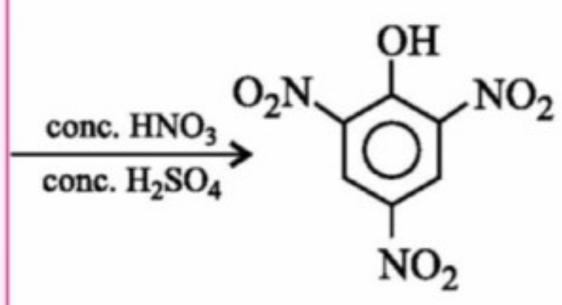


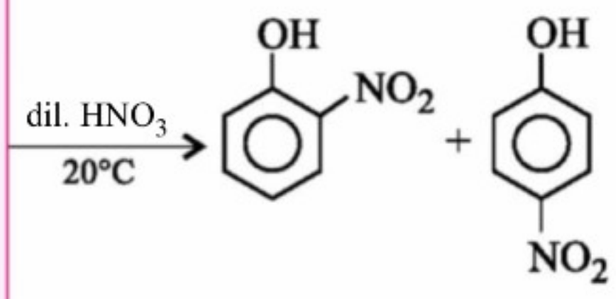
Chemical Properties

P

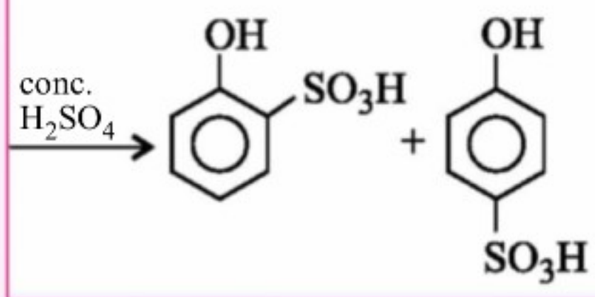


H



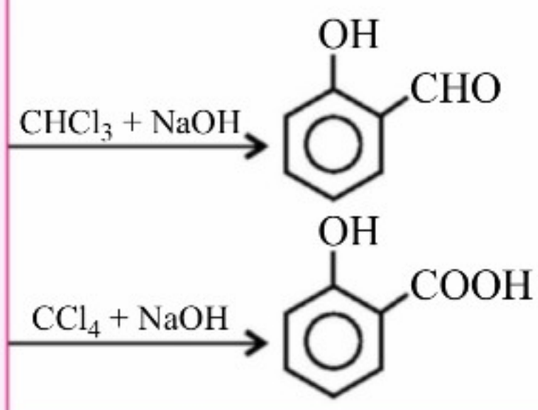


E



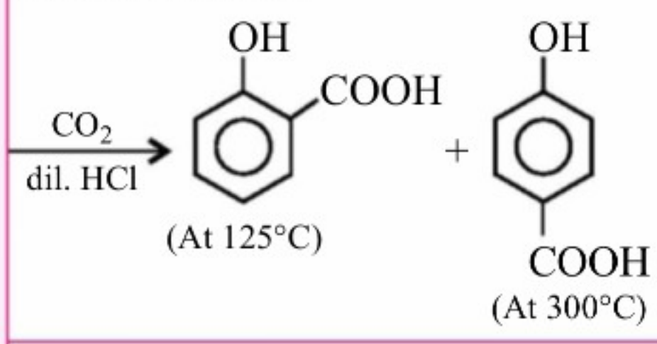
N

Reimer-Tiemann reaction



O

Kolbe's reaction



L

$$C_6H_5OH \xrightarrow[\Delta]{Zn} C_6H_6 + ZnO$$

$$C_6H_5OH \xrightarrow[\text{Anhy. } ZnCl_2]{NH_3} C_6H_5NH_2 + H_2O$$

S

$$C_6H_5OH \xrightarrow[Py]{ROCl \text{ or } (RCO)_2O} C_6H_5OCOR + HCl$$

$$C_6H_5OH \xrightarrow[K_2Cr_2O_7]{2[O]} O{=}C_6H_4{=}O$$

$$C_6H_5OH \xrightarrow[-260°C]{H_2/Ni} C_6H_{11}OH$$

Cyclohexanol

Ethers

Methods of Preparation

By dehydration of alcohols (E, T, H)

$$ROH + HOR \xrightarrow[413\ K]{\text{Conc. } H_2SO_4}$$

$$ROH + HOR \xrightarrow{Al_2O_3,\ 633\ K}$$

$$ROH + CH_2N_2 \xrightarrow{HBF_4}$$

From alkyl halides (E)

$$2R{-}X + Ag_2O \xrightarrow{\Delta}$$

$$R{-}X + RONa \xrightarrow{\Delta}$$

From Grignard reagent (R)

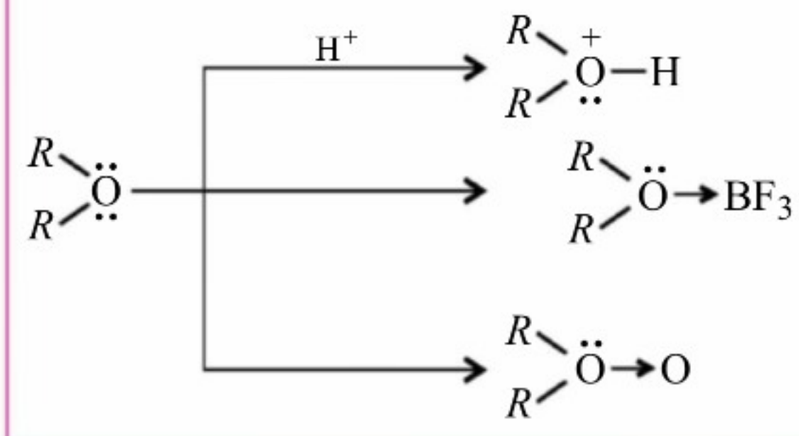
$$CH_3{-}O{-}CH_2Cl + CH_3MgI \longrightarrow$$

Preparation of cyclic ethers (or epoxides) (S)

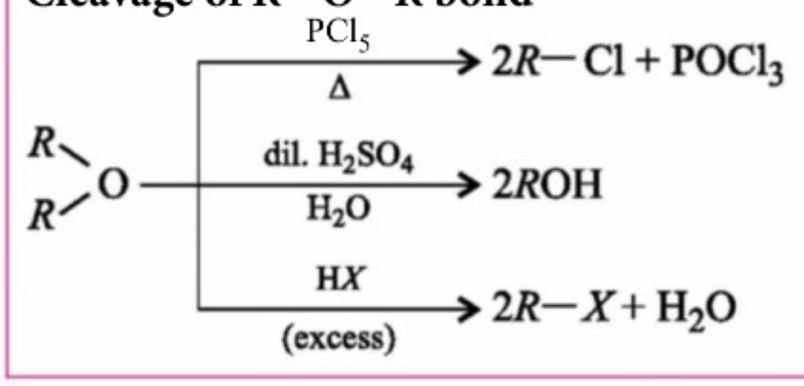
$$CH_2{=}CH_2 + \tfrac{1}{2}O_2 \xrightarrow[200\text{–}400°C]{Ag}$$

Chemical Properties

Reactions of lone pair of oxygen

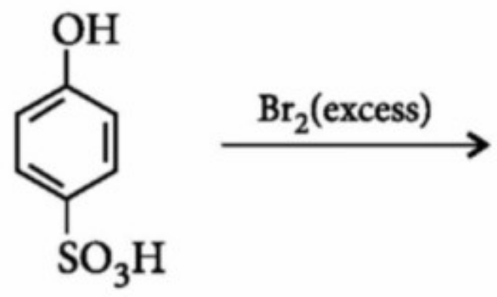


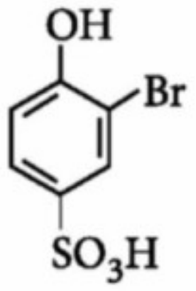
Cleavage of *R*—O—*R* bond

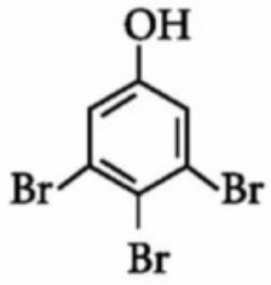


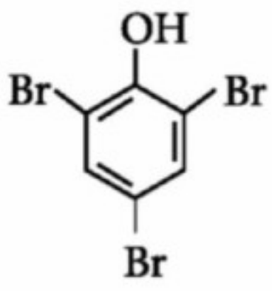
Peep Into Previous Years

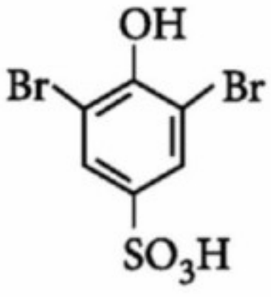
10. The major product of the following reaction is



(a) 

(b) 

(c) 

(d) 

(JEE Main 2019)

11. The heating of phenyl methyl ether with HI produces
(a) iodobenzene
(b) phenol
(c) benzene
(d) ethyl chloride.

(NEET 2017)

Points For Extra Scoring

Distinction test for 1°, 2° and 3° Alcohols

- **Lucas test :** Alcohol is treated with an equimolar mixture of concentrated hydrochloric acid and anhydrous $ZnCl_2$ (Lucas reagent).
  - If cloudiness appears immediately, the alcohol is tertiary.
  - If cloudiness appears within five minutes, the alcohol is secondary.
  - If cloudiness appears only upon heating, the alcohol is primary.
- **Victor Meyer's test :** Alcohol $\xrightarrow{\text{Red P} + I_2}$ *R*I $\xrightarrow{AgNO_2}$ Nitroalkane $\xrightarrow{NaNO_2 + \text{dil. } H_2SO_4}$ Solution made alkaline.
  - If blood red colour appears, alcohol is primary.
  - If blue colour appears, alcohol is secondary.
  - If colourless, alcohol is tertiary.

Distinction between Alcohols and Phenols

Test	Alcohol	Phenol
Litmus test	No effect	Turns blue litmus red
Reaction with $FeCl_3$	No reaction	Blue, violet or green colouration
Coupling reaction	No reaction	Forms yellow or orange coloured azo dyes.
Bromine water test	No reaction	A white ppt. of 2,4,6-tribromo phenol.

- Order of ease of cleavage of O—H bond and thus order of reactivity of alcohols is as follows :
  CH_3OH > Primary > Secondary > Tertiary
- Order of reactivity of different alcohols towards Fisher – Speier esterification is :
  $CH_3OH > RCH_2OH > R_2CHOH > R_3COH$
- Relative acidities of H_2O, *R*OH, CH≡CH, NH_3 and *R*H will be in order :
  $H_2O > ROH > CH{\equiv}CH > NH_3 > RH$
- Phenols are stronger acids than water and alcohols but weaker than carboxylic acids.
- Ethers (as Lewis bases) can form coordination complexes known as etherates with Lewis acids like BF_3, $AlCl_3$, *R*Mg*X*. That is why Grignard reagents are usually prepared in ethers.
- In presence of atmospheric oxygen, ethers oxidise slowly to produce hydroperoxides and dialkylperoxides, both of which are explosives (auto-oxidation). Formation of peroxide can be prevented by adding small amount of Cu_2O to ether.

Answer Key For Peep Into Previous Years

1.	(a)	2.	(a)	3.	(b)	4.	(a)	5.	(b)	6.	(b,d)
7.	(c)	8.	(b)	9.	(d)	10.	(c)	11.	(b)		

WRAP it up!

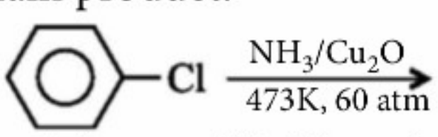
1. The ease of dehydrohalogenation of alkyl halides with alcoholic KOH is
(a) $3° < 2° < 1°$ (b) $3° > 2° > 1°$
(c) $3° < 2° > 1°$ (d) $2° > 3° > 1°$

2. Cumene process is the most important commercial method for the manufacture of phenol. Cumene is
(a) *iso*-propyl benzene (b) ethyl benzene
(c) vinyl benzene (d) propyl benzene.

3. $C_2H_5OC_2H_5$ absorbs oxygen in presence of light to form
(a) acetic acid (b) ether suboxide
(c) ether peroxide (d) ethyl alcohol.

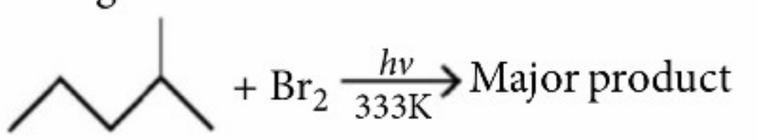
4. The conversion of *m*-nitrophenol to resorcinol involves respectively
(a) hydrolysis, diazotization and reduction
(b) diazotization, reduction and hydrolysis
(c) hydrolysis, reduction and diazotization
(d) reduction, diazotization and hydrolysis.

5. Predict the main product.



(a) Phenyl cyanide (b) Nitrophenol
(c) Aniline (d) Hydroxylamine

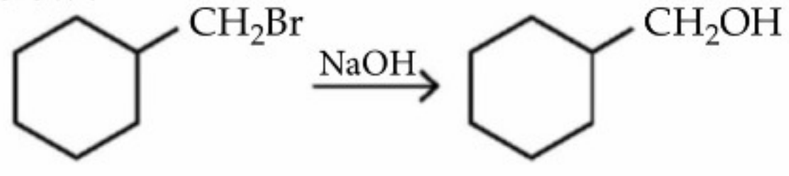
6. Which of the following is the major product of the following reaction?



(a) 3-Bromo-2-methylpentane
(b) 2-Bromo-2-methylpentane
(c) 1-Bromo-2-methylpentane
(d) 4-Bromo-2-methylpentane

7. During S_N1 reaction which of the following species is produced?
(a) Free radical (b) Carbene
(c) Carbocation (d) Carbanion

8. Suggest the suitable solvent for the reaction given below :



(a) H_2O (b) C_2H_5OH
(c) $HCONMe_2$ (d) C_6H_6

9. The S_N1 reactivity of the following halides will be in the order
(i) $(CH_3)_3CBr$ (ii) $(C_6H_5)_2CHBr$
(iii) $(C_6H_5)_2C(CH_3)Br$ (iv) $(CH_3)_2CHBr$
(v) C_2H_5Br
(a) (v) > (iv) > (i) > (ii) > (iii)
(b) (ii) > (i) > (iii) > (v) > (iv)
(c) (i) > (iii) > (v) > (ii) > (iv)
(d) (iii) > (ii) > (i) > (iv) > (v)

10. $(CH_3)_3C-O-CH_3$ —Conc. HI→ P_1 ; —Anhyd.HI→ P_2

The products P_1 and P_2 are respectively
(a) $(CH_3)_3COH + CH_3I$ and $(CH_3)_3CI + CH_3OH$
(b) $(CH_3)_3CI + CH_3OH$ and $(CH_3)_3COH + CH_3I$
(c) $(CH_3)_3CI + CH_3OH$ in both cases
(d) CH_3I and $(CH_3)_3COH$ in both cases.

11. Hexachloroethane is also called as _____ .
(a) gammaxene (b) artificial camphor
(c) pyrene (d) artificial silk

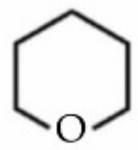
12. In Finkelstein reaction, which reactants are used
(a) $NaI + C_2H_5OH$ (b) NaF + acetone
(c) $NaBr + CH_3OH$ (d) $NaI + C_2H_5Br$

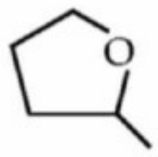
COMIC CAPSULE

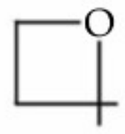
Why does hamburger have lower energy than steak?

Because it's in the ground state.

13. A chiral ether $C_5H_{10}O$ reacts with hot HI to give a $C_5H_{10}I_2$ product. Treatment of this with hot KOH in ethanol produces 1, 3-pentadiene. What is the structure of the original ether?

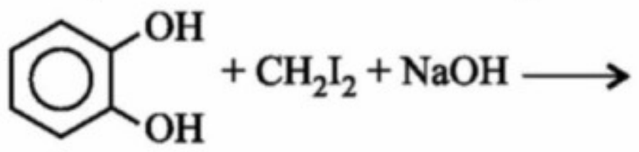
(a) 

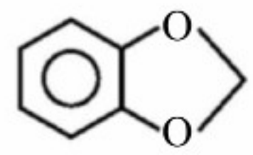
(b) 

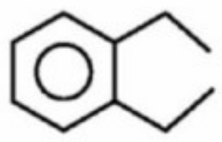
(c) 

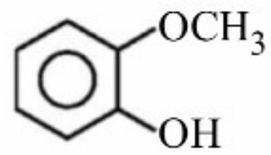
(d) 

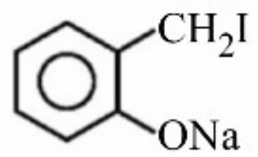
14. The product of the following reaction is



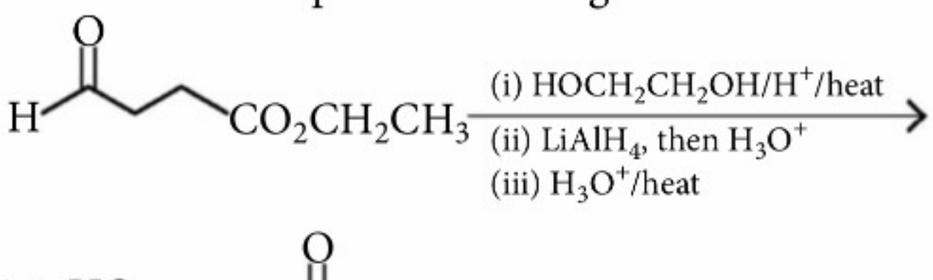
(a) 

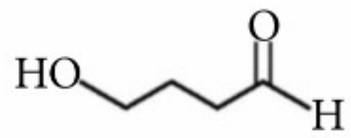
(b) 

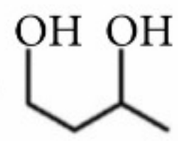
(c) 

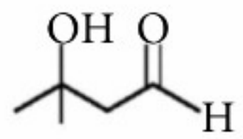
(d) 

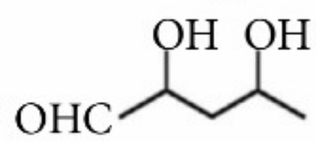
15. What will be the product of the given reaction?



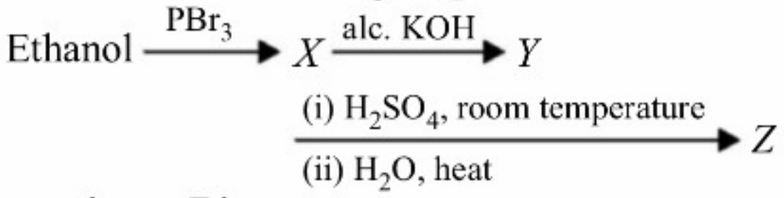
(a) 

(b) 

(c) 

(d) 

16. Consider the following sequence of reaction :



th p du t Z is

(a) $CH_3CH_2 - O - CH_2 - CH_3$

(b) $CH_3 - CH_2 - O - SO_3H$

(c) CH_3CH_2OH

(d) $CH_2 = CH_2$

17. The best method for the conversion of an alcohol into an alkyl chloride is by treating the alcohol with

(a) PCl_5

(b) $SOCl_2$ in presence of pyridine

(c) Dry HCl in the presence of anhydrous $ZnCl_2$

(d) PCl_3

18. The aromatic compound having molecular formula C_7H_8O which are easily identifiable by $FeCl_3$ solution test (Violet colouration) are

(a) *o*-cresol and benzyl alcohol

(b) *m*-cresol and *p*-cresol

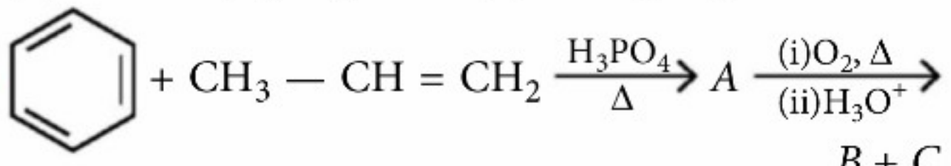
(c) *o*-cresol and *p*-cresol

(d) methyl phenyl ether and benzyl alcohol.

19. Zeisel's method is used to estimate

(a) alcoholic group (b) amino group

(c) methoxy group (d) halo group.

20. 

The products *B* and *C* are respectively

(a) phenol and acetic acid

(b) phenol and acetaldehyde

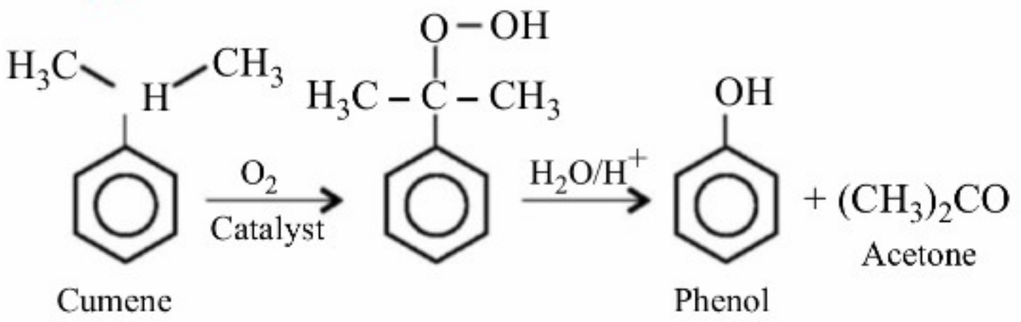
(c) benzoic acid and acetone

(d) phenol and acetone.

SOLUTIONS

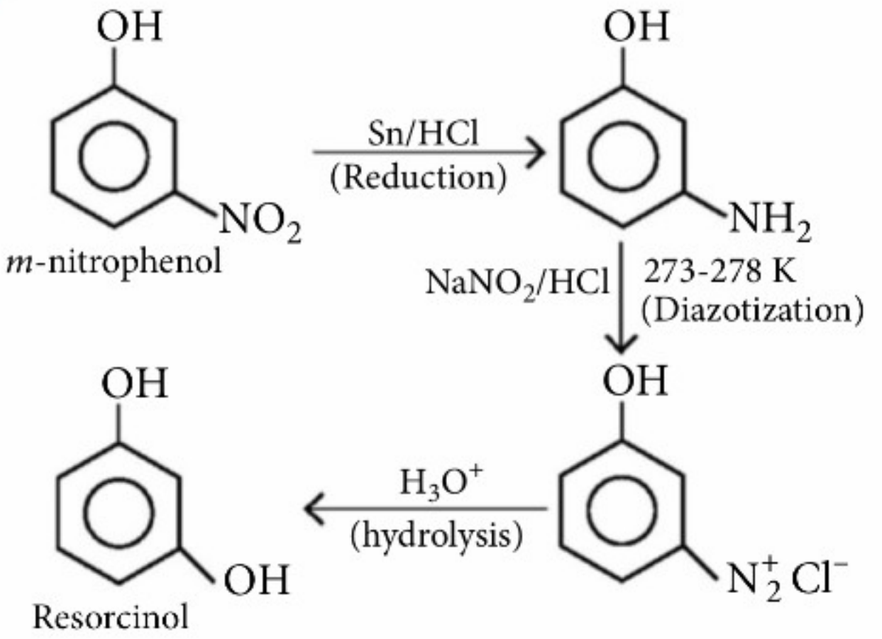
1. (b): Ease of dehydrohalogenation decreases in the order : 3° > 2° > 1°

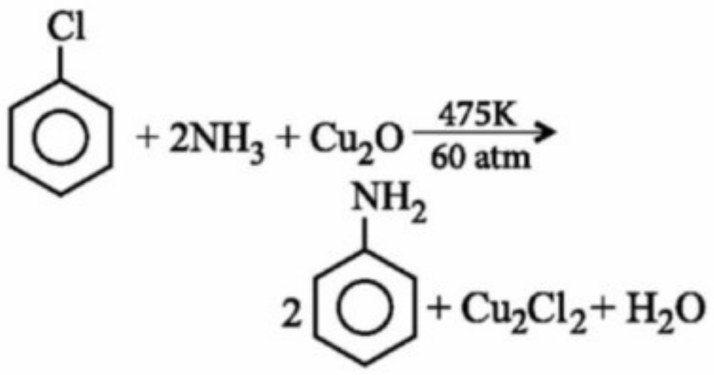
2. (a):



3. (c): When exposed to air and light for a long time, ethers are oxidised to form hydroperoxides or simply peroxides.

4. (d):



5. (c) : 

6. (b)

7. (c) :

$$R{-}X \xrightarrow[\text{slow}]{-X^-} \underset{\text{carbocation}}{R^+} \xrightarrow[\text{fast}]{Nu^-} R{-}Nu\ (S_N1 \text{ reaction})$$

8. (c) : S_N2 reaction proceed in polar aprotic solvents.

9. (d): The stability of carbocations follows the order :

$(C_6H_5)_2C^+(CH_3) > (C_6H_5)_2C^+H > (CH_3)_3C^+ > (CH_3)_2C^+H > CH_3C^+H_2$

$\therefore$ Order of reactivity towards S_N1 reaction is :

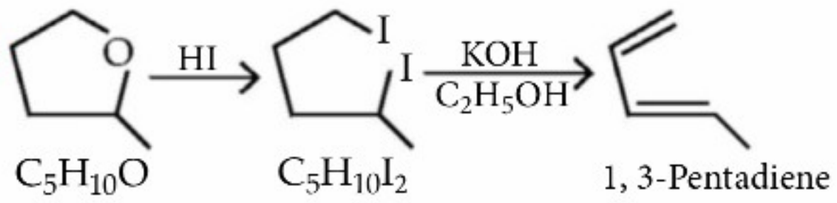
$$\underset{\text{(iii)}}{(C_6H_5)_2C(CH_3)Br} > \underset{\text{(ii)}}{(C_6H_5)_2CHBr} > \underset{\text{(i)}}{(CH_3)_3CBr} > \underset{\text{(iv)}}{(CH_3)_2CHBr} > \underset{\text{(v)}}{C_2H_5Br}$$

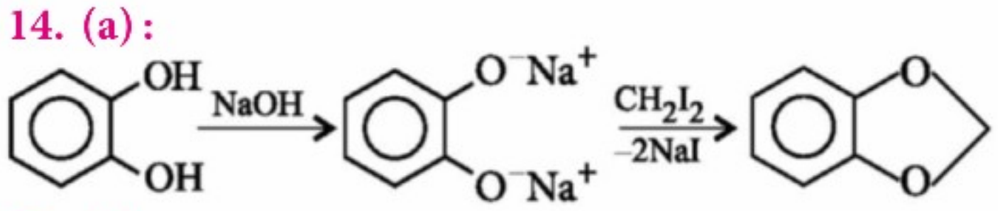
10. (b): When one of the alkyl groups is 3° and another is 1°, nature of reagent determines the type of mechanism (S_N1 or S_N2). A polar solvent or reagent capable of forming ions (viz conc. HI) will cause S_N1 reaction, while a non-polar solvent or a reagent not capable of forming ions (anhydrous HI) will cause S_N2 reaction.

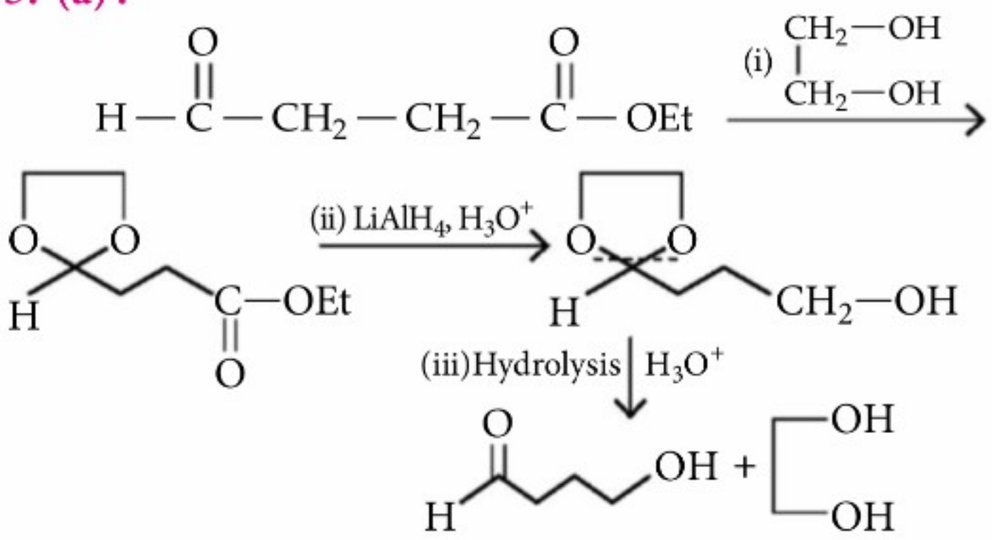
11. (b)

12. (d): $\underset{\text{Ethyl bromide}}{C_2H_5Br} + NaI \xrightarrow[\text{Heat}]{\text{Acetone}} \underset{\text{Ethyl iodide}}{C_2H_5I} + NaBr$

This reaction is called "Finkelstein reaction".

13. (b): 

14. (a): 

15. (a): 

16. (c) :

$$\underset{\text{Ethanol}}{C_2H_5OH} \xrightarrow{PBr_3} \underset{(X)}{C_2H_5Br} \xrightarrow[\text{dehydro-halogenation}]{\text{alc. KOH}} \underset{\substack{\text{Ethene}\\(Y)}}{CH_2=CH_2}$$

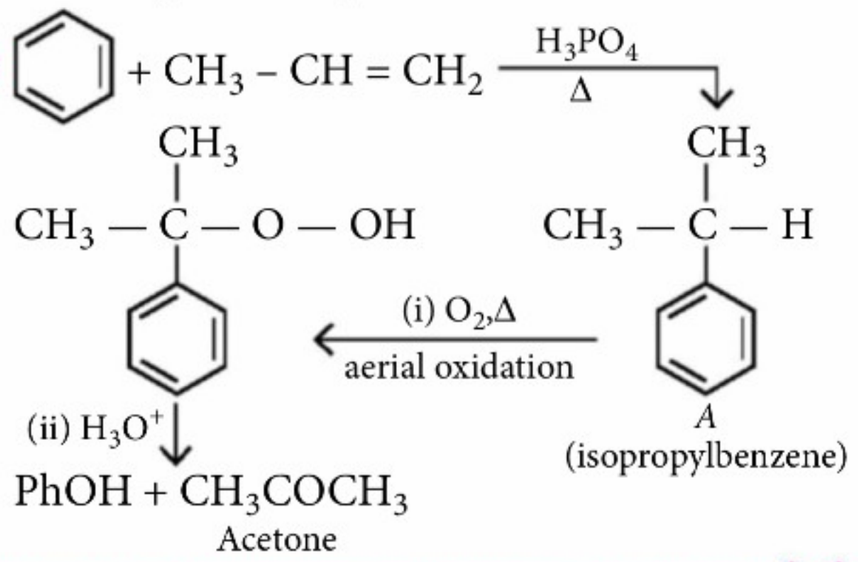
$$CH_2=CH_2 \xrightarrow{H_2SO_4} CH_3CH_2-HSO_4 \xrightarrow{H_2O} \underset{(Z)}{C_2H_5-OH}$$

17. (b): $R{-}OH + SOCl_2 \xrightarrow[\text{Reflux}]{\text{Pyridine}} R{-}Cl + SO_2\uparrow + HCl\uparrow$

This is the best method for preparing alkyl chloride from alcohols. The advantage of this method is that the by products of the above reaction, *i.e.*, SO_2 and HCl are gases which can easily escape from the reaction mixture.

18. (a): *o*-cresol is a phenol and hence give violet colour with $FeCl_3$ while benzyl alcohol being an alcohol does not give colour with $FeCl_3$.

19. (c): Zeisel's method is used to estimate the alkoxy linkages in an organic compound.

20. (d): 

CHEMISTRY PUZZLE SOLUTION — OCTOBER 2019

ETHER	ALKYL
SAPONIFICATION	ESTERIFICATION
MONOHYDROXY	COMBUSTION
ALKENE	ALKANE
ALDEHYDE	KETONE
SATURATED	CONDENSATION
SINGLE BOND	AMIDE
CARBOXYLIC ACID	ESTER
UNSATURATED	AROMATIC
RESONANCE	ACID ANHYDRIDE
BENZENE	OXIDATION
ISOMERISM	HYPERCONJUGATION

CBSE warm-up!

CLASS-XII

Chapterwise practice questions for CBSE Exams as per the latest pattern and marking scheme issued by CBSE for the academic session 2019-20.

Series 6 — Aldehydes, Ketones and Carboxylic Acids I Amines

Time Allowed : 3 hours
Maximum Marks : 70

GENERAL INSTRUCTIONS

(i) All questions are compulsory.
(ii) Section A: Q.no. 1 to 20 are very short answer questions (objective type) and carry 1 mark each.
(iii) Section B: Q.no. 21 to 27 are short answer questions and carry 2 marks each.
(iv) Section C: Q.no. 28 to 34 are long answer questions and carry 3 marks each.
(v) Section D: Q.no. 35 to 37 are also long answer questions and carry 5 marks each.
(vi) There is no overall choice. However an internal choice has been provided in two questions of two marks, two questions of three marks and all the three questions of five marks weightage. You have to attempt only one of the choices in such questions.
(vii) Use log tables if necessary, use of calculators is not allowed.

SECTION - A

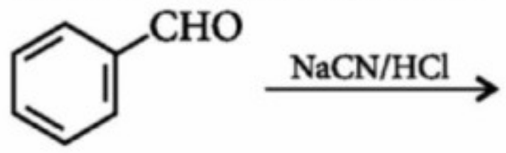
Read the given passage and answer the questions 1 to 5 that follow :

Amines have an unshared pair of electrons on nitrogen atom hence amines behave as a Lewis base. The basic character of amines can be expressed in terms of their K_b and pK_b values. Aliphatic amines are stronger bases than ammonia because $+I$ effect of alkyl groups increases electron density on nitrogen atom.

1. Out of 1°, 2° and 3° amine, which one of them is strongest base.
2. Write the increasing order of basicity of amines (in gaseous phase) of the given compounds : $(CH_3)_2NH$, NH_3, $(CH_3)_3N$, CH_3NH_2.
3. Write the factors on which basicity of amines depends in aqueous solution.
4. Why amines are more basic than alcohols?
5. Why pK_b of aniline is more than that of methyl amine?

Questions 6 to 10 are one word answers :

6. What is the major product of the given reaction?



7. Draw the structure of product of the given reaction.
$C_6H_5NH_2 + 3Br_{2(aq)} \longrightarrow$
8. Name the reagent used in the following reaction :
$CH_3—CO—CH_3 \xrightarrow{?} CH_3—\underset{\underset{OH}{|}}{CH}—CH_3$ *(Delhi 2015)*
9. Write the IUPAC name of the following compound:
$(CH_3)_2N — CH_2CH_3$
10. Name the compound formed when formaldehyde is treated with ammonia.

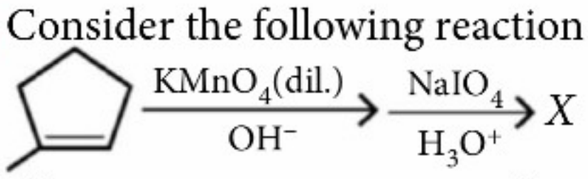
Questions 11 to 15 are Multiple choice questions :

11. Which of the following statements is not true about $>C=O$ group?

(a) The carbon atom of the carbonyl group is sp^2-hybridised.
(b) The C=O bond length is longer than that of C=C bond length.
(c) The dipole moments of aldehydes and ketones lie in the range 2.3-2.8 D.
(d) The portion of the molecule immediately surrounding the carbonyl group is planar.

12. An organic compound '*A*' on treatment with NH_3 gives '*B*' which on heating gives '*C*', '*C*' when treated with Br_2 in the presence of KOH produces ethylamine. Compound '*A*' is
(a) CH_3COOH (b) $CH_3CH_2CH_2COOH$
(c) $CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle |}{CH}}-COOH$ (d) CH_3CH_2COOH

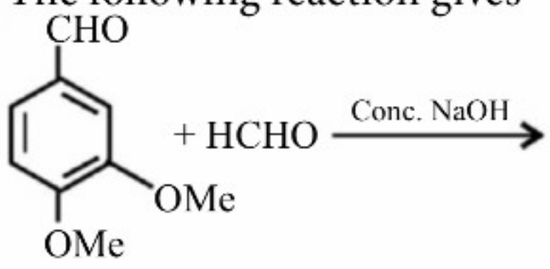
13. Consider the following reaction sequence :

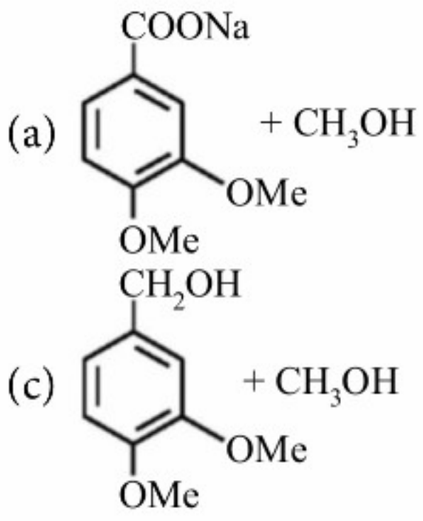


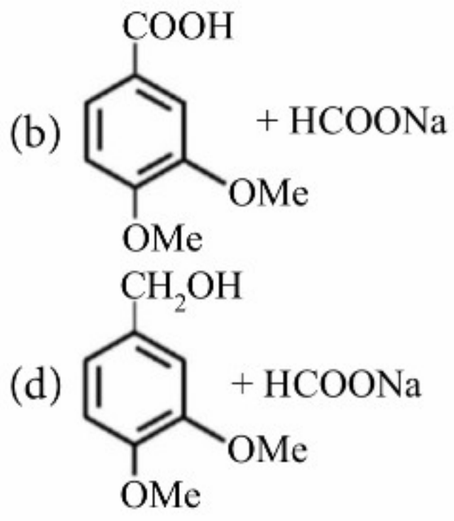
The correct statement regarding *X* is
(a) it has only an aldehyde functional group
(b) it has both aldehyde and ketone functional groups
(c) it has only a ketone functional group
(d) it has a ketone and an acid functional group.

14. The correct order of basic strength in aqueous solutions is
(a) $CH_3NH_2 > (CH_3)_2NH > (CH_3)_3N > NH_3$
(b) $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N > NH_3$
(c) $NH_3 > (CH_3)_3N > CH_3NH_2 > (CH_3)_2NH$
(d) $(CH_3)_3N > (CH_3)_2NH > CH_3NH_2 > NH_3$

15. The following reaction gives



(a) 

(b) 

(c)

(d)

Questions 16 to 20 :
(a) Both assertion and reason are correct statements, and reason is the correct explanation of the assertion.
(b) Both assertion and reason are correct statements, but reason is not the correct explanation of the assertion.
(c) Assertion is correct, but reason is wrong statement.
(d) Assertion is wrong, but reason is correct statement.

16. **Assertion :** Acetaldehyde undergoes aldol condensation with dilute NaOH.
Reason : Aldehydes which do not contain α-hydrogen undergo aldol condensation.

17. **Assertion :** In order to convert *R*–Cl to pure *R*–NH_2, Gabriel phthalimide synthesis can be used.
Reason : With proper choice of alkyl halides, pthalimide synthesis can be used to prepare 1°, 2° or 3° amines.

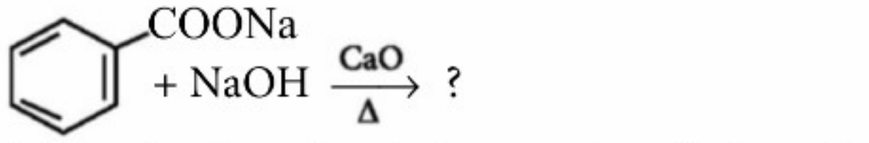
18. **Assertion :** Carboxylic acids do not give characteristic reactions of carbonyl group.
Reason : Carboxylic acids exist as cyclic dimers in solid, liquid and even in vapour state.

19. **Assertion :** Nitration of aniline gives out predominantly *meta* substituted product.
Reason : Aniline is a weaker base than ethylamine.

20. **Assertion :** HCHO facilitates better nucleophilic attack than acetone, CH_3COCH_3.
Reason : Formaldehyde is more polar than acetone.

SECTION - B

21. **(a)** Write the product in the following reaction :

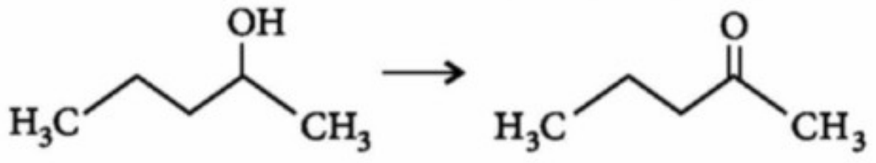


(b) Give simple chemical test to distinguish between the following pair of compounds: Benzoic acid and phenol
(AI 2017, AI 2014, Delhi 2013C, 2012, 2012 C, 2010)

22. Why primary amines have higher boiling points than tertiary amines?

OR

Illustrate the following reactions giving suitable example in each case :
(i) Ammonolysis
(ii) Acetylation of amines

23. Suggest suitable reagents for the following conversions :
(a) $CH_3CH_2CH_2CH_2CH_2OH \longrightarrow CH_3CH_2CH_2CH_2CHO$
(b) 

24. What happens when

(i) Aniline is heated with acidified $K_2Cr_2O_7$ solution?

(ii) Benzene is heated with hydroxyl amine in presence of anhydrous $AlCl_3$?

25. Why aldehydes are more reactive than ketones towards nucleophilic reagents?

OR

Write the reactions involved in the following:

(i) Hell-Volhard-Zelinsky reaction

(ii) Decarboxylation reaction

26. Electrophilic substitution in case of aromatic amines (arylamines) takes place more readily than benzene. Explain.

27. Arrange the following in the increasing order of boiling points :

(a) C_3H_7CHO, $CH_3COC_2H_5$, $C_2H_5COOCH_3$, $(CH_3CO)_2O$

(b) Complete the following reaction :

$$CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-COOH \xrightarrow[(ii)\ H_2O]{(i)\ Br_2/Red\ P_4}$$

SECTION-C

28. (a) How will you bring about the following conversions in not more than two steps?

(i) Benzene to *m*-nitroacetophenone

(ii) 2-Methylpropanol to 2-methylpropene

(b) There are two $-NH_2$ groups in semicarbazide. However, only one such group is involved in the formation of semicarbazone. Explain.

OR

(i) Arrange the following compounds in increasing order of their reactivity in nucleophilic addition reactions :

(a) Ethanal, Propanal, Propanone, Butanone.

(b) Benzaldehyde, *p*-Tolualdehyde, *p*-Nitrobenzaldehyde, Acetophenone.

(ii) Give plausible explanation for the following : During the preparation of esters from a carboxylic acid and an alcohol in the presence of an acid catalyst, the water or the ester should be removed as soon as it is formed.

29. How will you convert :

(i) Ethanoic acid into methanamine

(ii) Ethanamine into methanamine

(iii) Nitromethane into dimethylamine

30. (a) Cyclohexanone forms cyanohydrin in good yield but 2,2,6-trimethylcyclohexanone does not. Explain.

(b) Benzaldehyde can be obtained from benzal chloride. Write reactions for obtaining benzal chloride and then benzaldehyde from it.

31. Suggest chemical reactions for the following conversions :

(i) Cyclohexanol to Cyclohexylamine

(ii) 1-Hexanenitrile to 1-Aminopentane

OR

(i) Write the structures of *A*, *B* and *C* in the following reactions :

(a)
$$C_6H_5NO_2 \xrightarrow{Sn+HCl} A \xrightarrow[273\ K]{NaNO_2+HCl} B \xrightarrow[\Delta]{H_2O} C$$

(b)
$$CH_3Cl \xrightarrow{KCN} A \xrightarrow{LiAlH_4} B \xrightarrow[273\ K]{HNO_2} C$$

32. (i) State reasons for the following :

(a) Monochloroethanoic acid has a higher pK_a value than dichloroethanoic acid.

(b) Ethanoic acid is a weaker acid than benzoic acid.

(ii) How will you convert the following : Ethanal to 2-hydroxypropanoic acid.

33. Give the structures of products *A*, *B* and *C* in the following reactions :

(i)
$$CH_3CH_2Br \xrightarrow{KCN} A \xrightarrow{LiAlH_4} B \xrightarrow[0°C]{HNO_2} C$$

(ii)
$$CH_3COOH \xrightarrow[\Delta]{NH_3} A \xrightarrow{NaOH+Br_2} B \xrightarrow[Alc.\ NaOH]{CHCl_3+} C$$

34. (*A*), (*B*) and (*C*) are three non-cyclic functional isomers of a carbonyl compound with molecular formula C_4H_8O. Isomers (*A*) and (*C*) give positive Tollens' test whereas isomer (*B*) does not give Tollens' test but gives positive iodoform test. Isomers (*A*) and (*B*) on reduction with Zn(Hg)/conc. HCl give the same product (*D*).

(a) Write the structures of (*A*), (*B*), (*C*) and (*D*).

(b) Out of (*A*), (*B*) and (*C*) isomers, which one is least reactive towards addition of HCN?

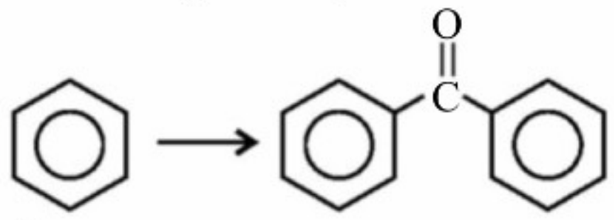
(2018)

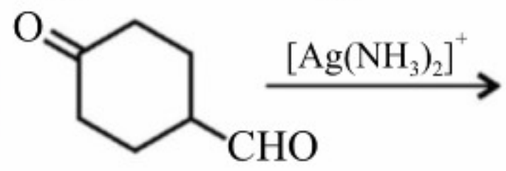
SECTION-D

35. An organic compound *A* (C_3H_6O) is resistant to oxidation but forms compound *B* (C_3H_8O) on reduction. *B* reacts with HBr to form the compound *C*. *C* with Mg forms Grignard reagent *D* which reacts with *A* to form a product which on hydrolysis gives *E*. Identify *A* to *E*.

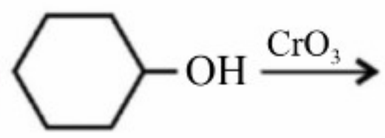
OR

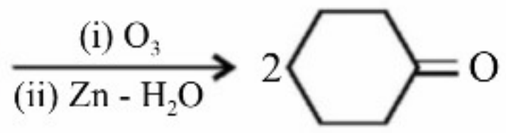
Complete each synthesis by giving missing starting materials, reagents or products.

(i) 

(ii) 

(iii) $CH_3COCH_2COOC_2H_5 \xrightarrow[(ii)\ H^+]{(i)\ NaBH_4}$

(iv) 

(v) 

36. (a) Suggest chemical reaction for the following conversions :

(i) Aniline to benzoic acid

(ii) Aniline to benzyl alcohol

(iii) *p*-Chloroaniline to *p*-chlorobenzylamine

(b) Account for the following :

(i) Aqueous solution of methyl amine reacts with iron(III) chloride to precipitate iron(III) hydroxide.

(ii) The boiling points of amines are lower than those of corresponding alcohols.

OR

(a) How is aminoethane obtained from ethanal?

(b) Give reasons :

(i) Nitrobenzene does not undergo Friedel—Crafts alkylation.

(ii) Silver chloride dissolves in methylamine solution.

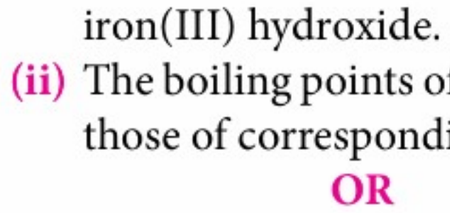
(iii) Write the chemical reaction for the reduction of nitroethane by $LiAlH_4$.

37. (i) Give a chemical test to distinguish between the following :

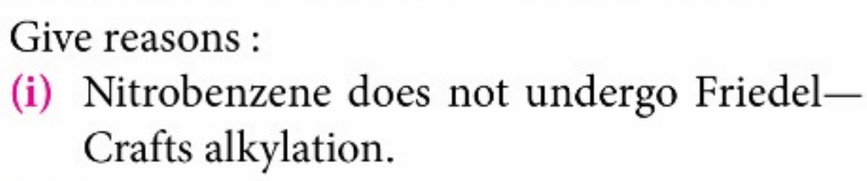
(a) Benzoic acid and ethyl benzoate

(b) Benzophenone and acetophenone.

(ii) Complete the following reaction :



(iii) Identify *A*, *B* and *C* in the following sequence:



OR

Write down functional isomers of a carbonyl compound with molecular formula C_3H_6O. Which isomer will react faster with HCN and why? Explain the mechanism of the reaction also. Will the reaction lead to the completion with the conversion of whole reactant into product at reaction conditions? If a strong acid is added to the reaction mixture what will be the effect on concentration of the product and why?

SOLUTIONS

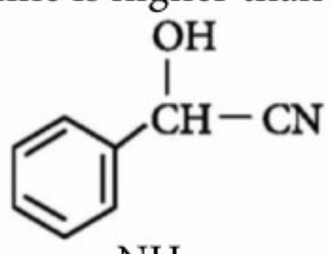
1. 3° amine

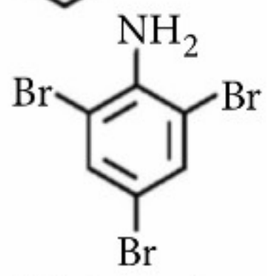
2. $(CH_3)_3N > (CH_3)_2NH > CH_3NH_2 > NH_3$

3. The basicity of amines depends on solvation effect and steric hindrance in addition to inductive effect.

4. Nitrogen being less electronegative than oxygen gives lone pair of electron more easily than oxygen atom.

5. In methylamine, the electron releasing effect of $-CH_3$ group increases the electron density on nitrogen atom of amine group. Whereas in aniline, the electron density is decreased due to the delocalisation of the lone pair of electron over the benzene ring. Therefore pK_b of aniline is higher than that of methyl amine.

6. 

7. 

8. Lithium aluminium hydride ($LiAlH_4$)

9. *N*,*N*-Dimethylethanamine

10. Hexamethylene tetraamine (urotropine)

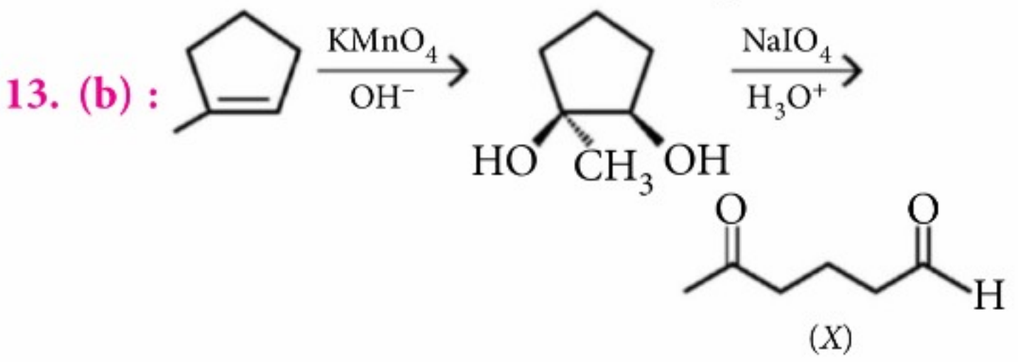
11. (b) : Due to smaller size of oxygen than carbon, C=O double bond is shorter (1.23 Å) than C=C double bond (1.35 Å).

12. (d) : $CH_3CH_2COOH \xrightarrow{NH_3} CH_3CH_2COONH_4$

Propanoic acid (*A*) — Amm. propanoate (*B*)

$\xrightarrow[H_2O]{\Delta} CH_3CH_2CONH_2 \xrightarrow[\text{(Hoffmann bromamide reaction)}]{Br_2/KOH} CH_3CH_2NH_2$

Propanamide (*C*) — Ethylamine

13. (b) : 

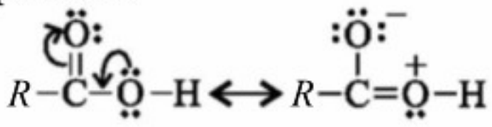
14. (b) : Since alkyl groups are electron releasing, electron density on the nitrogen atom is increased and alkylamines are more basic than ammonia. As a result, the basic character should decrease in the order, 3° amine > 2° amine > 1° amine. But due to the combined effect *i.e.*, inductive effect (+*I*), steric factors and solvation of ions the basicity decreases in the order, 2° amine > 1° amine > 3° amine > NH_3 for lower aliphatic amines.

15. (d) : Two non-enolisable aldehydes and NaOH indicates that it is an example of crossed Cannizaro reaction. Benzaldehyde derivative is converted to alcohol not formaldehyde.

16. (c) : Aldehydes which do not contain α-hydrogen, do not undergo aldol condensation.

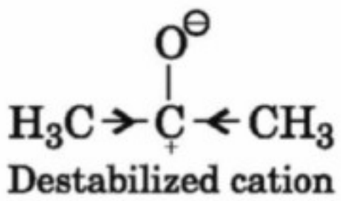
17. (c) : Only primary aliphatic amines can be prepared by Gabriel phthalimide reaction.

18. (b) : As carboxylic acids are resonance stabilized they do not contain true carbonyl group as is present in carbonyl compounds.

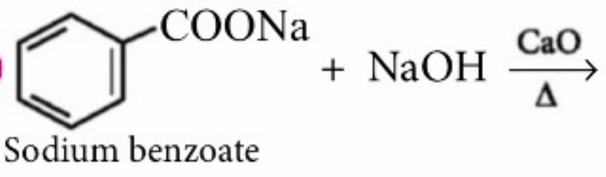


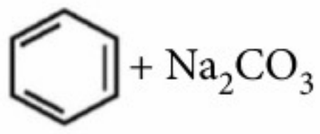
19. (b) : Nitration of aniline gives predominantly *meta* substituted product. The lone pair of electrons on the N-atom in aniline is delocalised over the benzene ring and hence it is less easily available for protonation. Therefore, aniline is a weaker base than ethylamine.

20. (c) : $-CH_3$ is electron donating species so, it will destabilize the +ve charge created on carbonyl carbon, so, formaldehyde is a better choice for nucleophilic attack.

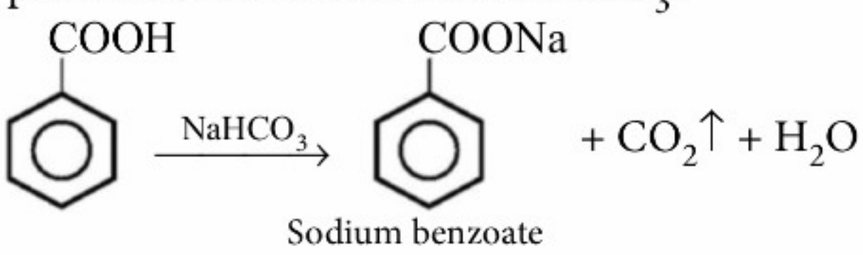


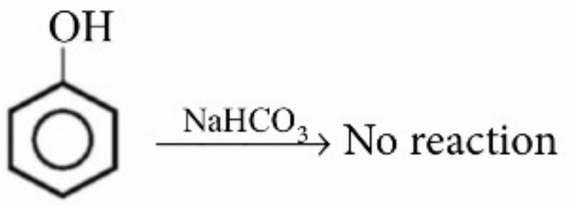
21. (a)





(b) Benzoic acid will react with $NaHCO_3$ to yield sodium benzoate with effervescence of CO_2 whereas phenol does not react with $NaHCO_3$.

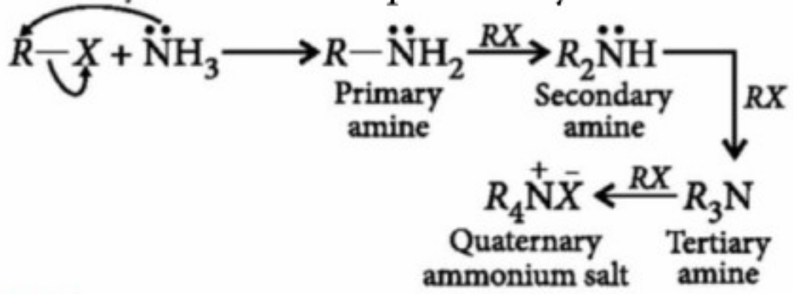




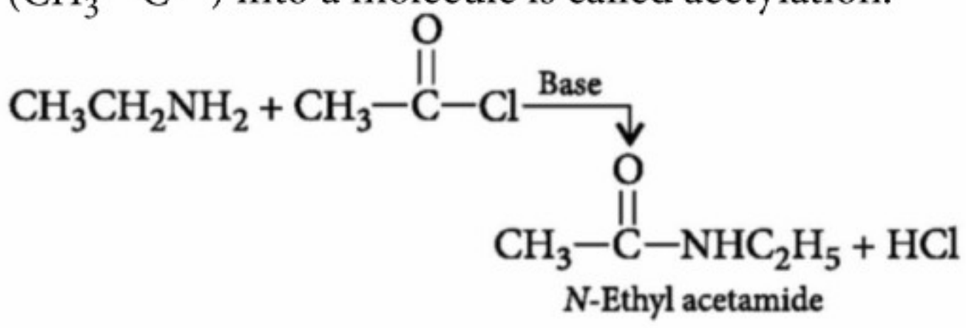
22. Primary amines (R–NH_2) have two hydrogen atoms on nitrogen which can undergo intermolecular hydrogen bonding whereas no such hydrogen bonding is present in tertiary amines (R_3N). So, primary amines boil at a higher temperature than tertiary amines.

OR

(i) Alkyl halides when treated with ethanolic solution of ammonia give a mixture of primary, secondary, tertiary amines and quaternary ammonium salt.

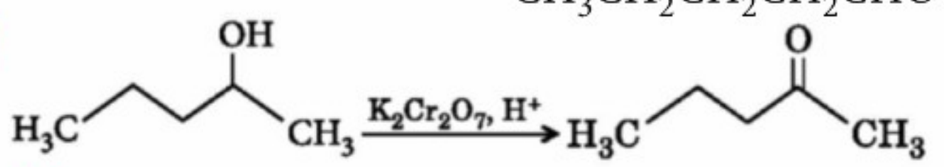


(ii) The process of introducing an acetyl group (CH$_3$—C(=O)—) into a molecule is called acetylation.

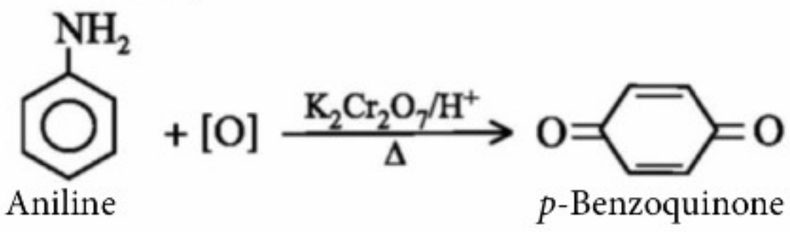


23. (a) $CH_3CH_2CH_2CH_2CH_2OH \xrightarrow[\Delta,\ 573\ K]{Cu} CH_3CH_2CH_2CH_2CHO$

(b)



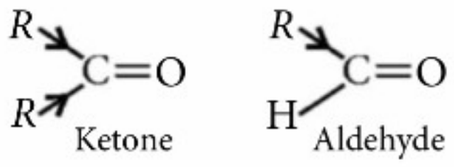
24. (i) Aniline on heating with acidified $K_2Cr_2O_7$ solution, gives the oxidation product *para*–benzoquinone (yellow in colour).



(ii) Aniline is produced, when benzene is heated with hydroxyl amine in presence of anhydrous $AlCl_3$.

$$\underset{\text{Benzene}}{C_6H_6} + HO - NH_2 \xrightarrow[\Delta]{\text{anhy. } AlCl_3} \underset{\text{Aniline}}{C_6H_5 - NH_2} + H_2O$$

25. Ketones are less reactive than aldehydes towards nucleophilic addition reactions because :
The two electron releasing alkyl groups decrease the magnitude of positive charge on carbonyl carbon and make it less susceptible to nucleophilic attack.



The two bulkier alkyl groups hinder the approach of the nucleophile to the carbonyl carbon. This is called steric factor.

OR

(i) Hell-Volhard-Zelinsky reaction : Carboxylic acids react with chlorine or bromine in the presence of phosphorous to give compounds in which α-hydrogen atom is replaced by halogen atom.

$$\underset{\text{Acetic acid}}{CH_3COOH} + Cl_2 \xrightarrow{\text{Red P}} \underset{\text{Chloroacetic acid}}{ClCH_2-COOH} + HCl$$

$$ClCH_2-COOH + Cl_2 \xrightarrow{\text{Red P}} \underset{\text{Dichloroacetic acid}}{Cl_2CHCOOH} + HCl$$

$$Cl_2CHCOOH + Cl_2 \xrightarrow{\text{Red P}} \underset{\text{Trichloroacetic acid}}{Cl_3CCOOH} + HCl$$

(ii) Decarboxylation : Sodium or potassium salt of carboxylic acids on heating with soda lime (NaOH and CaO), loses a molecule of carbon dioxide and alkanes are obtained as products.

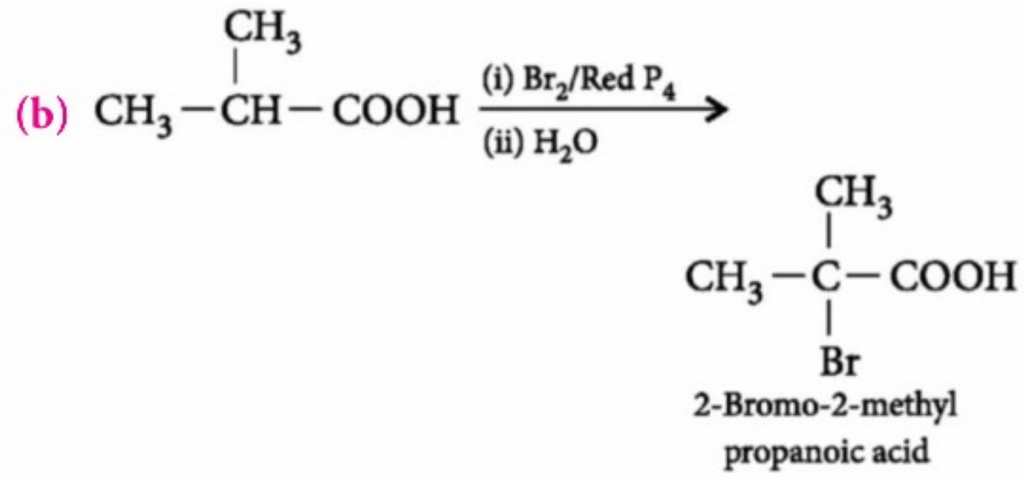
$$R-\overset{\overset{O}{\|}}{C}-O^-Na^+ + NaOH \xrightarrow{CaO} R-H + Na_2CO_3$$

26. $-NH_2$ group is an electron-releasing (activating) group. It activates the benzene ring (in arylamines) due to delocalization of the lone pair of electrons on the N-atom over the benzene ring. This makes electrophilic substitution in aromatic amines easier as compared to benzene.

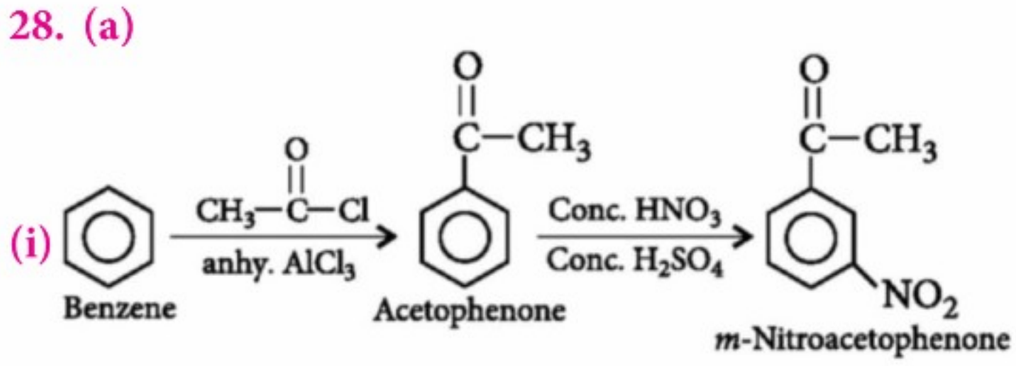
27. (a) C_3H_7CHO is an aldehyde, $CH_3COC_2H_5$ is a ketone, $C_2H_5COOCH_3$ is an ester and, $(CH_3CO)_2O$ is an acid anhydride.

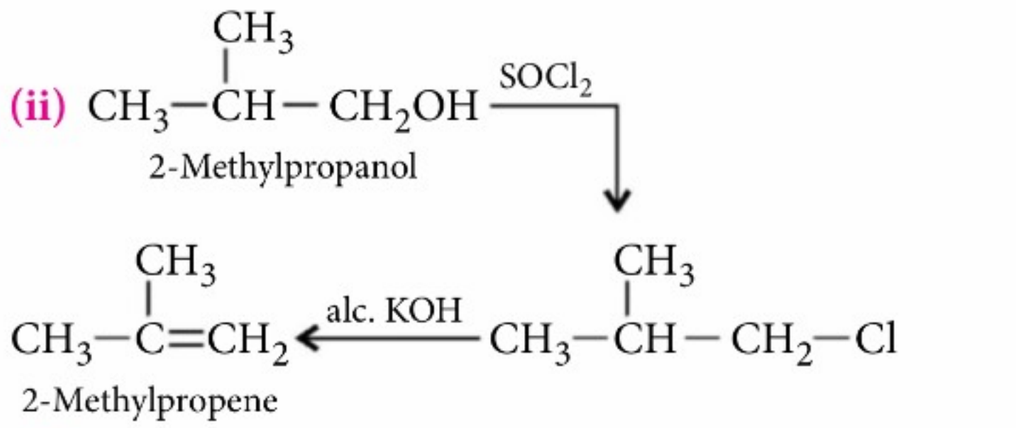
None of the four compounds are capable of forming hydrogen bonds. Therefore, the boiling point is greatly influenced by the molar mass of the compound, and complexity of their structures. Thus, the boiling points are expected to follow the order,

$C_3H_7CHO < CH_3COC_2H_5 \simeq C_2H_5COOCH_3 < (CH_3CO)_2O$

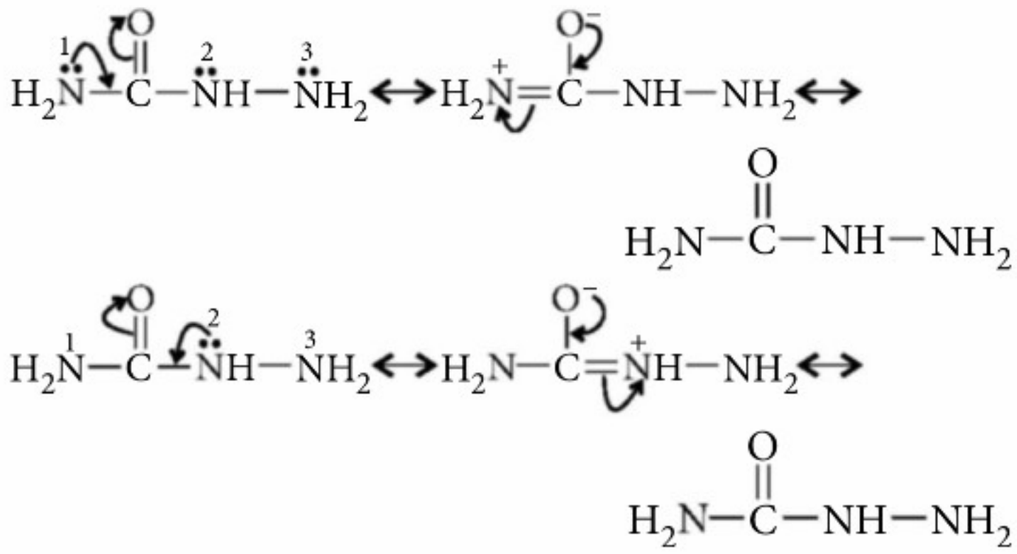
(b)


28. (a)

(i)


(ii)


(b) Semicarbazide has the following resonance structures arising due to the electron withdrawing nature of the O atom.



Lone pairs of N-1 and N-2 are involved in conjugation with $>C=O$ group while that of N-3 is not involved in resonance thus, it is involved in the formation of semicarbazone.

OR

(i) (a) Butanone < Propanone < Propanal < Ethanal

This is due to increasing $+I$ effect of alkyl group from ethanal to butanone which increases the electron density on carbonyl carbon and hence, attack by the nucleophile becomes slower and slower.

(b) Acetophenone < *p*-Tolualdehyde < Benzaldehyde < *p*-Nitrobenzaldehyde

This is due to :

- ketones are less reactive than aldehydes towards nucleophilic addition reactions.
- CH_3 group increases the electron density on carbonyl carbon while nitro group decreases the electron density.

(ii) $\underset{\text{Acid}}{RCOOH} + \underset{\text{Alcohol}}{R'OH} \overset{H^+}{\rightleftharpoons} \underset{\text{Ester}}{RCOOR'} + H_2O$

The esterification reaction is a reversible reaction. If water and the ester are allowed to remain in the reaction mixture the hydrolysis of the ester would take place. Hence, water or ester should be removed as soon as it is formed.

29. (i) $CH_3COOH \xrightarrow{PCl_5} CH_3-\overset{O}{\overset{\|}{C}}-Cl \xrightarrow{NH_3} CH_3-\overset{O}{\overset{\|}{C}}-NH_2 \xrightarrow{Br_2/\,KOH} CH_3-NH_2$

Ethanoic acid (Acetic acid) — Methanamine

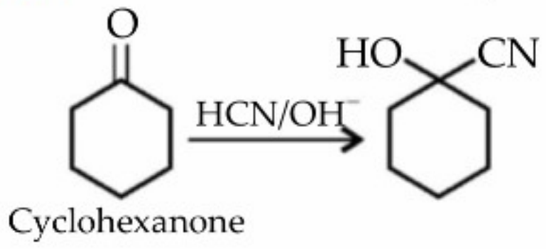
(ii) $CH_3-CH_2-NH_2 \xrightarrow[273\,-\,278\ K]{NaNO_2\,/\,HCl} CH_3-CH_2-OH \xrightarrow{K_2Cr_2O_7/H^+} CH_3-COOH \xrightarrow{PCl_5} CH_3-COCl \xrightarrow{NH_3} CH_3-CONH_2 \xrightarrow{Br_2\,/\,KOH} CH_3-NH_2$

Ethanamine — Methanamine

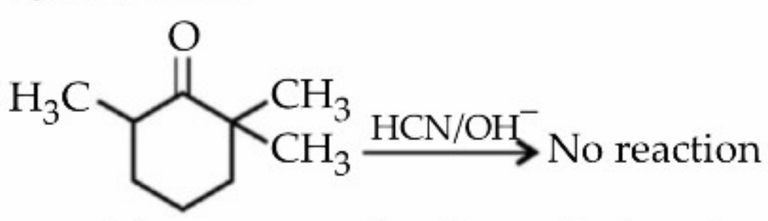
(iii) $CH_3-NO_2 \xrightarrow{Sn\,/\,HCl} CH_3-NH_2 \xrightarrow[\Delta]{CHCl_3\,/\,KOH} CH_3-NC \xrightarrow{Na\,/\,C_2H_5OH} CH_3-NH-CH_3$

Nitromethane — Dimethylamine

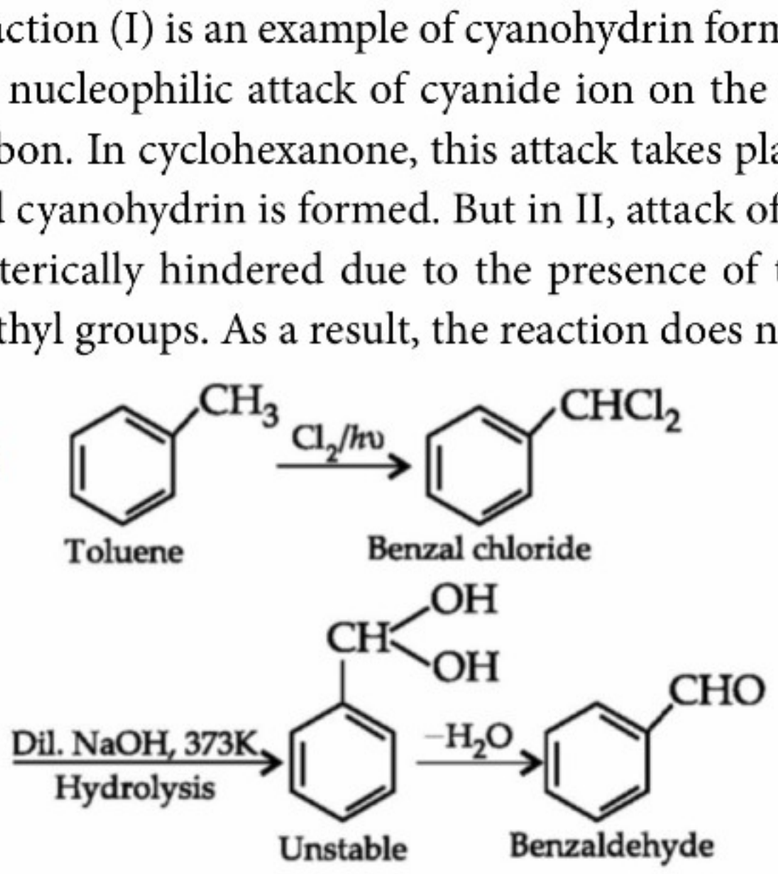
30. (a) Consider the following reactions :

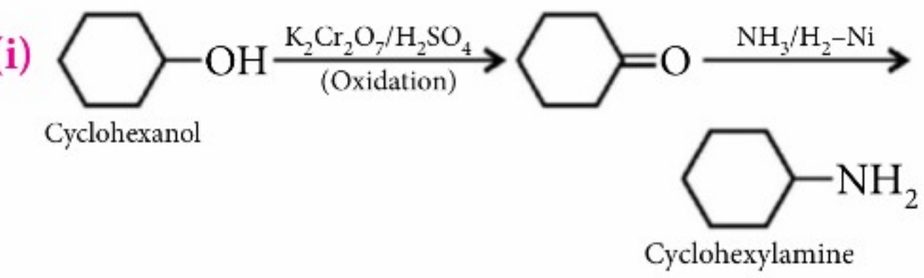
(I) 

Cyclohexanone

(II) 

Reaction (I) is an example of cyanohydrin formation by the nucleophilic attack of cyanide ion on the carbonyl carbon. In cyclohexanone, this attack takes place easily and cyanohydrin is formed. But in II, attack of the Nu– is sterically hindered due to the presence of the three methyl groups. As a result, the reaction does not occur.

(b) 

31. (i) 

Cyclohexanol — Cyclohexylamine

(ii) $CH_3CH_2CH_2CH_2CH_2C\equiv N \xrightarrow[(Hydrolysis)]{H^+/H_2O}$

1-Hexanenitrile

$CH_3(CH_2)_4COOH \xrightarrow{NH_3} CH_3(CH_2)_4COO^-\,NH_4^+$

Hexanoic acid

$\xrightarrow[-H_2O]{\Delta} CH_3(CH_2)_4CONH_2 \xrightarrow[(Hoffmann\ bromamide\ reaction)]{NaOH/Br_2}$

Hexanamide

$CH_3CH_2CH_2CH_2CH_2NH_2$

1-Aminopentane

OR

(a) $C_6H_5NO_2 \xrightarrow{Sn\,+\,HCl} C_6H_5NH_2$ (*A*)

$C_6H_5N_2^+Cl^- \xrightarrow[\Delta]{H_2O} C_6H_5OH$ (*C*) ; $C_6H_5N_2^+Cl^- \xleftarrow[273\ K]{NaNO_2\,+\,HCl}$ (*B*)

(b) $CH_3Cl \xrightarrow{KCN} CH_3CN \xrightarrow{LiAlH_4} CH_3CH_2NH_2$

A — *B*

$CH_3CH_2NH_2 \xrightarrow[273\ K]{HNO_2} CH_3CH_2OH$

C

32. (i) (a) The strength of an acid is indicated by pK_a value, where, $pK_a = -\log K_a$

Since monochloroethanoic acid is weaker acid than dichloroethanoic acid so, it has lower value of dissociation constant K_a. Therefore, it has higher value of pK_a.

(b) —COOH group in benzoic acid is attached to sp^2-carbon of the phenyl ring and is more acidic than acetic acid in which —COOH group is attached to sp^3-carbon atom of $—CH_3$ group.

(ii) $CH_3CHO \xrightarrow{HCN} CH_3-\underset{OH}{\underset{|}{CH}}-CN \xrightarrow{Hydrolysis} CH_3-\overset{H}{\overset{|}{\underset{OH}{\underset{|}{C}}}}-COOH$

2-Hydroxypropanoic acid

33. (i) $CH_3CH_2Br \xrightarrow{KCN} CH_3CH_2CN \xrightarrow{LiAlH_4} CH_3CH_2CH_2NH_2$

(*A*) — (*B*)

$CH_3CH_2CH_2OH \xleftarrow[HNO_2]{273\ K} CH_3CH_2CH_2NH_2$

(*C*) — (*B*)

(ii) $CH_3COOH \xrightarrow[\Delta]{NH_3} CH_3CONH_2 \xrightarrow{Br_2\,+NaOH} CH_3NH_2$

(*A*) — (*B*)

$CH_3NC \xleftarrow{CHCl_3\,+\,NaOH} CH_3NH_2$

(*C*) — (*B*)

34. (a) As (*A*) and (*C*) give positive Tollens' test thus these two should be aldehyde while (*B*) should be a ketone (does not give Tollens' test) with $-\overset{\overset{O}{\|}}{C}-CH_3$ group (as it gives positive iodoform test).

Three isomers are

$CH_3CH_2CH_2CHO$ (*A*), $CH_3-\overset{\overset{O}{\|}}{C}-CH_2-CH_3$ (*B*), $CH_3-\underset{\underset{CH_3}{|}}{CH}-CHO$ (*C*)

$$CH_3CH_2CH_2CHO \xrightarrow{Zn(Hg)/conc.\ HCl} CH_3CH_2CH_2CH_3$$
(*A*) (*D*)

$$CH_3-\overset{\overset{O}{\|}}{C}-CH_2-CH_3 \xrightarrow{Zn(Hg)/conc.\ HCl} CH_3CH_2CH_2CH_3$$
(*B*) (*D*)

(b) Out of (*A*), (*B*) and (*C*) isomers, (*B*) is least reactive towards addition of HCN.

35. $\underset{(C_3H_6O)}{CH_3CH_2CHO} \xrightarrow{Reduction} \underset{(C_3H_8O)}{CH_3CH_2CH_2OH}$
Propanal (*A*) — 1-Propanol (*B*)

$$\xrightarrow[-H_2O]{HBr} \underset{(C)}{CH_3CH_2CH_2Br} \xrightarrow{Mg} \underset{(D)}{CH_3CH_2CH_2MgBr}$$
(Propyl bromide) — (Propyl magnesium bromide)

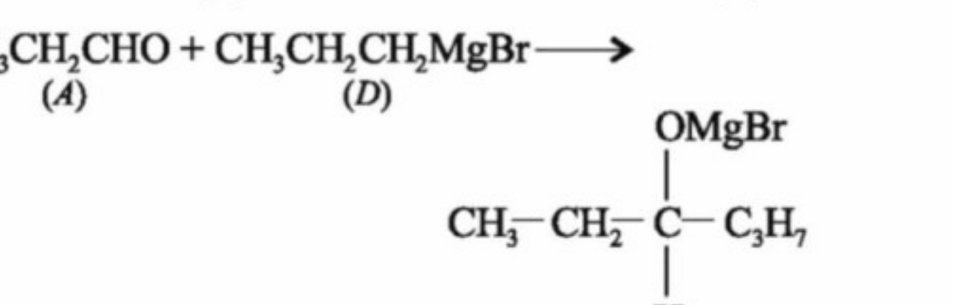
$$CH_3CH_2CHO + CH_3CH_2CH_2MgBr \longrightarrow$$
(*A*) (*D*)

$CH_3-CH_2-\underset{\underset{H}{|}}{\overset{\overset{OMgBr}{|}}{C}}-C_3H_7$

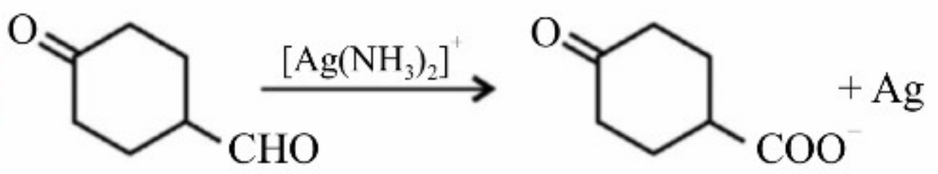
$$\xrightarrow[Hydrolysis]{H_2O,\ H^+} C_2H_5-\underset{\underset{H}{|}}{\overset{\overset{OH}{|}}{C}}-C_3H_7 + Mg(OH)Br$$
(Hexan-3-ol) (*E*)

Therefore, (*A*) : Propanal
(*B*) : 1-Propanol
(*C*) : Propyl bromide
(*D*) : Propyl magnesium bromide
(*E*) : Hexan-3-ol

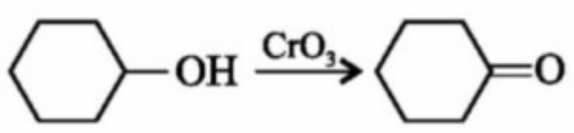
OR

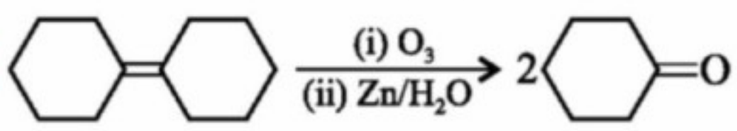
(i) 

Benzophenone

(ii) 

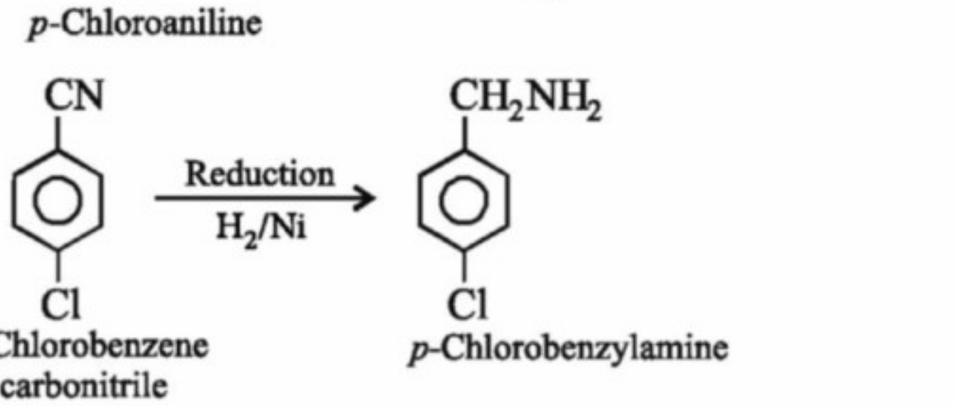
(iii) $CH_3-\overset{\overset{O}{\|}}{C}-CH_2-\overset{\overset{O}{\|}}{C}-O-C_2H_5 \xrightarrow[(ii)\ H^+]{(i)\ NaBH_4} CH_3-\underset{\underset{OH}{|}}{CH}-CH_2-\overset{\overset{O}{\|}}{C}-O-C_2H_5$

(iv) 

(v) 

36. (a) (i) $\underset{\text{Aniline}}{C_6H_5NH_2} \xrightarrow[273\ K]{NaNO_2 + HCl} \underset{\text{Benzenediazonium chloride}}{C_6H_5\overset{+}{N}_2Cl^-}$

$$\xrightarrow[Pyridine]{CuCN} C_6H_5CN \xrightarrow[Hydrolysis]{H_2O/H^+} \underset{\text{Benzoic acid}}{C_6H_5COOH}$$

(ii) 

(iii)

(b) (i) Methyl amine reacts with water to form methyl ammonium hydroxide which is more basic than NH_4OH and ionizes to give OH^- ions.

$$CH_3NH_2 + H_2O \rightarrow \overset{+}{C}H_3NH_3 + OH^-$$

$$FeCl_3 + 3OH^- \rightarrow \underset{\text{Red brown ppt.}}{Fe(OH)_3\downarrow} + 3Cl^-$$

(ii) As oxygen is more electronegative than nitrogen therefore, hydrogen bonding among alcohol molecules is stronger than among amine molecules. So, alcohols have higher boiling points than amines.

OR

(a) $CH_3-\underset{\text{Ethanal}}{\overset{H}{\overset{|}{C}}}=O + NH_3 \xrightarrow[-H_2O]{\Delta} CH_3-\underset{\text{Acetaldimine}}{\overset{H}{\overset{|}{C}}}=NH \xrightarrow{H_2/Ni} \underset{\text{Aminoethane}}{CH_3CH_2NH_2}$

(b) (i) Due to strong electron withdrawing effect of $-NO_2$ group, the benzene ring in nitrobenzene is deactivated towards Friedel—Crafts reaction.

(ii) Amines form soluble co-ordination compounds with Ag^+ ions. Therefore white ppt. of silver chloride is dissolved in methylamine solution.

$$\underset{\text{Silver chloride (insoluble)}}{AgCl} + 2CH_3-\ddot{N}H_2 \longrightarrow \underset{\text{(soluble)}}{[(CH_3NH_2)_2Ag]Cl}$$

(iii) $\underset{\text{Nitroethane}}{CH_3CH_2NO_2} + 6[H] \xrightarrow[\text{Ether}]{LiAlH_4} CH_3CH_2NH_2 + 2H_2O$

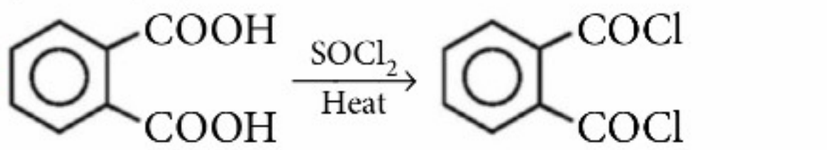
37. (i) (a) $C_6H_5COOH + NaHCO_3 \longrightarrow C_6H_5COONa + H_2O + CO_2\uparrow$ (Effervescence)

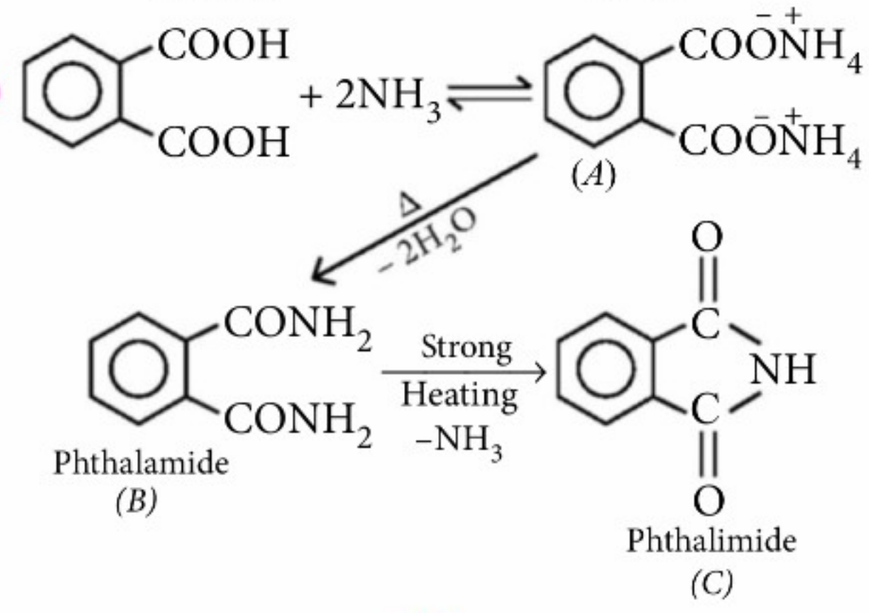
$C_6H_5COOC_2H_5 + NaHCO_3 \longrightarrow$ No reaction

(b) Acetophenone with $I_2/NaOH$ gives yellow precipitate of iodoform but benzophenone does not.

$C_6H_5COCH_3 + 3I_2 + 4NaOH \longrightarrow C_6H_5COONa + CHI_3\downarrow + 3NaI + 3H_2O$ (Yellow ppt.)

$C_6H_5COC_6H_5 + I_2 + NaOH \longrightarrow$ No reaction

(ii) 

(iii) 

OR

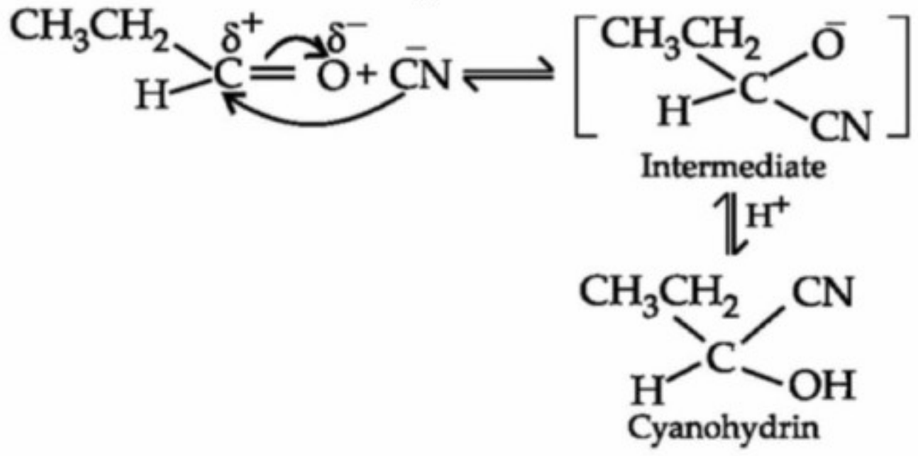
C_3H_6O will have following isomers :

(I) CH_3CH_2CHO (II) CH_3COCH_3

Compound I will react faster with HCN due to less steric hindrance and greater positive charge on carbon atom of carbonyl group. Two methyl groups increase electron density on carbonyl carbon in compounds II hence the rate of nucleophilic attack is less.

Mechanism of the reaction:

$HCN + OH^- \rightarrow CN^- + H_2O$



The reaction will not lead to completion since it is a reversible reaction, hence equilibrium is established.

If a strong acid is added to reaction mixture the addition is inhibited because the formation of CN^- ions form HCN is prevented.

Two from Delhi bag medals at Moscow Science Olympiad

Months of preparation paid off for Harshita and Satyam, the two 17-year-olds from South West Delhi, who bagged medals at an International Science Olympiad held in Moscow in September.

The teenagers are students of class XII at Rajkiya Pratibha Vikas Vidyalaya (RPVV) in Dwarka and won bronze medals in Chemistry at the Fourth International Olympiad of Metropolises in Moscow. A team of eight students from six different RPVVs had boarded a flight to Moscow on August 31. However, Harshit said, their journey had begun several months ago in April when they gave their first screening test for the competition in their respective schools.

"We went through three levels of screening before the final selection and began preparation around one-and-a-half months before the competition. The teachers who had gone for the Olympiad last year had told us how to prepare for the practical and theory sections, and we practised for an hour after classes every alternate day," said Satyam.

He said that the practice required for the competition was different from what they followed in schools for exams. "In our schools, we are required to learn a concept and then apply it to answer questions. For a competition like an Olympiad, the practical aspect is far more closely tied to learning," he said. Harshita said that they visited laboratories of Hindu College and Rajdhani College as part of their preparation: "We got to see the equipment which we don't have in schools."

On 16th September, Delhi Education Minister Manish Sisodia said that the government would set up training cells to train students for competitions of this nature, and that students between 14 and 18 years will be selected to undergo this training.

MONTHLY TEST DRIVE

This specially designed column enables students to self analyse their extent of understanding of specified chapters. Give yourself four marks for correct answer and deduct one mark for wrong answer. Self check table given at the end will help you to check your readiness.

The Solid State | Solutions

Total Marks : 120 **Time Taken : 60 Min.**

NEET / AIIMS

Only One Option Correct Type

1. Which of the following statements about the NaCl crystal is correct?
(a) Cl^- ions are present at the corners face centres and Na^+ ions at the body-centre and edge centres.
(b) Cl^- ions adopt *bcc* arrangement.
(c) The NaCl structure has 6 : 4 coordination.
(d) Na^+ ions are at the edge centres only.

2. A liquid is in equilibrium with its vapour at its boiling point. On the average, the molecules in the two phase have equal
(a) intermolecular forces
(b) potential energy
(c) temperature
(d) kinetic energy.

3. CaO and NaCl have same crystal structure and nearly the same ionic radii. If X is the lattice energy of NaCl, the lattice energy of CaO is very nearly
(a) X (b) $2X$ (c) $4X$ (d) $X/4$

4. The Henry's law constant for the solubility of N_2 gas in water at 298 K is 1.0×10^5 atm. The mole fraction of N_2 in air is 0.8. The number of moles of N_2 from air dissolved in 10 moles of water at 298 K and 5 atm pressure is
(a) 4.0×10^{-4} (b) 4.0×10^{-5}
(c) 5.0×10^{-4} (d) 4.0×10^{-6}

5. The elevation in boiling point of a solution of 13.44 g of $CuCl_2$ in 1 kg of water using the following information will be (Molecular weight of $CuCl_2$ = 134.4 and $K_b = 0.52$ molal^{-1})
(a) 0.156 (b) 0.052 (c) 0.13 (d) 0.25

6. Copper crystallizes in *fcc* with a unit cell length of 361 pm. What is the radius of copper atom?
(a) 108.5 pm (b) 127.6 pm
(c) 157 pm (d) 181 pm

7. If the ratio of coordination number P to that of Q be $Y : Z$, then the formula of the solid is
(a) $P_Z Q_Y$ (b) $P Q_{YZ}$
(c) $P_{1/Y} Q_{1/Z}$ (d) $P_Y Q_Z$

8. The aqueous solution that has the lowest vapour pressure at a given temperature is
(a) 0.1 molal calcium phosphate
(b) 0.1 molal barium chloride
(c) 0.1 molal sodium chloride
(d) 0.1 molal glucose.

9. What is the density of an element, which has *fcc* crystal lattice with cell edge of 400 pm? (Atomic mass = 60)
(a) 6.23 g cm^{-3} (b) 7.43 g cm^{-3}
(c) 8.53 g cm^{-3} (d) 9.63 g cm^{-3}.

10. A binary solid (A^+B^-) has a rock salt structure. If the edge length is 400 pm and radius of cation is 75 pm, then radius of anion is
(a) 100 pm (b) 125 pm
(c) 250 pm (d) 325 pm.

11. Two solutions of a substance (non-electrolyte) are mixed in the following manner : 480 mL of 1.5 M first solution + 520 mL of 1.2 M second solution. What is the molarity of the final mixture?
(a) 1.20 M (b) 1.50 M
(c) 1.344 M (d) 2.70 M

12. Two solutions of KNO_3 and CH_3COOH are prepared separately. The molarity of both is 0.1 M and osmotic pressure is P_1 and P_2, respectively. The correct relationship between the osmotic pressures is

(a) $P_2 > P_1$ (b) $P_1 = P_2$

(c) $P_1 > P_2$ (d) $\frac{P_1}{P_1+P_2} = \frac{P_2}{P_1+P_2}$

Assertion & Reason Type

Directions : In the following questions, a statement of assertion is followed by a statement of reason. Mark the correct choice as :

(a) If both assertion and reason are true and reason is the correct explanation of assertion.

(b) If both assertion and reason are true but reason is not the correct explanation of assertion.

(c) If assertion is true but reason is false.

(d) If both assertion and reason are false.

13. **Assertion :** Group-13 doped crystals of Si are called *p*-type semiconductors.
Reason : Positive holes are responsible for the semiconducting properties.

14. **Assertion :** Henry's law and Raoult's law are not independent, *i.e.*, one can be derived from the other.
Reason : The partial pressure is directly proportional to the mole fraction of the concerned species for ideal solutions.

15. **Assertion :** Graphite is an example of tetragonal crystal system.
Reason : For a tetragonal system, $a = b \neq c$ and $\alpha = \beta = 90°, \gamma = 120°$.

JEE MAIN / ADVANCED

Only One Option Correct Type

16. In a spinel structure, oxides ions are cubical close packed, whereas 1/8 of tetrahedral holes are occupied by cations A^{2+} and 1/2 of octahedral holes are occupied by cations B^{3+} ions. The general formula of the compound having spinel structure is

(a) AB_2O_4 (b) $A_2B_2O_4$

(c) A_2B_6O (d) A_4B_3O

17. Calculate the normal boiling point of a sample of sea water found to contain 3.5% of NaCl and 0.13% of $MgCl_2$ by mass. The normal boiling point of water is 100°C and K_b (water) = 0.51 K kg mol^{-1}. Assume that both the salts are completely ionised.

(a) 105.455 °C (b) 106.600 °C

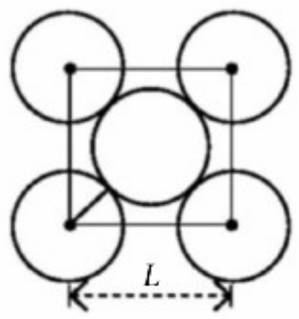
(c) 100.655 °C (d) 111.555 °C

18. Solution of a non-volatile solute in water freezes at –0.30°C. The vapour pressure of pure water at 298 K is 23.51 mm Hg and K_f for water is 1.86 degree/molal. What would be the vapour pressure of this solution at 298K?

(a) 23.44 mm Hg (b) 43.22 mm Hg

(c) 49.20 mm Hg (d) 30.12 mm Hg

19. The packing efficiency of the two-dimensional square unit cell shown below is



(a) 39.27%

(b) 68.02%

(c) 74.05%

(d) 78.54%

More than One Options Correct Type

20. In a body-centred cubic unit cell of A_2 type

(a) the edge length is equal to $\frac{4r}{\sqrt{3}}$

(b) the edge length is equal to $(2r^2 + 2r^2)$

(c) the edge length is equal to $\frac{2d}{\sqrt{3}}$ where d is the minimum distance between two lattice points

(d) the square of the edge length is equal to $16r^2$ where 'r' is the radius of a lattice point.

21. In the depression of freezing point experiment, it is found that the

(a) vapour pressure of the solution is less than that of pure solvent

(b) vapour pressure of the solution is more than that of pure solvent

(c) only solute molecules solidify at the freezing point

(d) only solvent molecules solidify at the freezing point.

22. The correct statements regarding defects in solids are

(a) Frenkel defect is usually favoured by a very small difference in the sizes of cation and anion

(b) Frenkel defect is a dislocation defect

(c) trapping of an electron in the lattice leads to the formation of F-center

(d) Schottky defects have no effect on the physical properties of solids.

23. Which of the following combinations are correct for binary solution, in which the solute as well as solvent are liquid?

(a) C_6H_6 and $C_6H_5CH_3$; $\Delta_{sol}H > 0$; $\Delta_{sol}V = 0$

(b) $CH_3-\overset{\overset{O}{\|}}{C}-CH_3$ and $CHCl_3$; $\Delta_{sol}H < 0$; $\Delta_{sol}V < 0$

(c) H_2O and HCl; $\Delta_{sol}H > 0$; $\Delta_{sol}V < 0$

(d) H_2O and CH_3OH; $\Delta_{sol}H > 0$; $\Delta_{sol}V > 0$

Numerical Value Type

24. An ionic solid A^+B^- crystallizes as a body-centred cubic structure. The distance between cation and anion in the lattice is 338 pm, then the edge length of the unit cell (in pm) is

25. 17.4% (w/V) K_2SO_4 solution is isotonic to 5.85% (w/V) NaCl solution at 27°C. If NaCl is 100% ionised, then % ionisation of K_2SO_4 in aqueous solution is

26. A motor vehicle radiator was filled with 8 L of water to which 2 L of methyl alcohol (density 0.8 g/mL) were added. The lowest temperature (in °C) at which the vehicle can be parked outdoors without a danger that water in the radiator will freeze is [K_f of water = 1.86 K m^{-1}]

Matrix Match Type

Answer the following questions (27 and 28) by appropriately matching the columns based on the information given in the passage :

Ideal solution is a solution in which the interactions between A and B are of the same magnitude as in the pure components, or is a solution which obeys Raoult's law at all temperatures and concentrations.

Non-ideal solution is a solution in which $A - B$ interactions are of different magnitudes than those in pure components. These solutions do not obey Raoult's law.

	Column-I (Solution)		Column-II (Characteristics)
A.	C_2H_5OH - H_2O	P.	$\Delta H = 0$
B.	H_2O - HNO_3	Q.	$\Delta V > 0$
C.	C_6H_5Cl - C_6H_5Br	R.	$\Delta H < 0$
D.	CCl_4 - CH_3OH	S.	$p_1 > p_1^0 x_1$

27. Which of the following has the correct combination considering column-I and column-II?

(a) A → R, S (b) B → P, Q, S

(c) C → R, S (d) D → Q, S

28. Which of the following has the correct combination considering column-I and column-II?

(a) A → P, R, S (b) B → R

(c) C → R, Q (d) D → P, Q, R

Answer the following questions (29 and 30) by appropriately matching the columns based on the information given in the passage :

Magnetic properties of solids are classified as :

Diamagnetism : The substances which are weakly repelled by magnetic field are called diamagnetic substances.

Paramagnetism : The substances which are weakly attracted by magnetic field are called paramagnetic substances.

Ferromagnetism : Unlike paramagnetic substances, ferromagnetic substances show permanent magnetism even when the magnetic field is removed.

Antiferromagnetism : Alignment of magnetic moments in opposite directions in a compensatory manner and resulting in a zero magnetic moment.

Ferrimagnetism : It is observed when the magnetic moments of the domains in the substance are aligned in parallel and anti-parallel directions in unequal numbers.

	Column-I		Column-II
A.	TiO	P.	Diamagnetic
B.	TiO_2	Q.	Ferromagnetic
C.	V_2O_3	R.	Ferrimagnetic
D.	CrO_2	S.	Paramagnetic
E.	Fe_3O_4	T.	Antiferromagnetic.

29. Which of the following has the correct combination considering column-I and column-II?

(a) A → S (b) B → T (c) C → Q (d) D → R

30. Which of the following has the correct combination considering column-I and column-II?

(a) A → R (b) B → Q (c) C → T (d) D → P

Keys are published in this issue. Search now! ☺

SELF CHECK

No. of questions attempted .....
No. of questions correct .....
Marks scored in percentage .....

Check your score! If your score is

> 90%	EXCELLENT WORK !	You are well prepared to take the challenge of final exam.
90-75%	GOOD WORK !	You can score good in the final exam.
74-60%	SATISFACTORY !	You need to score more next time.
< 60%	NOT SATISFACTORY!	Revise thoroughly and strengthen your concepts.

CHEMISTRY MUSING

PROBLEM SET 76

Chemistry Musing was started from August '13 issue of Chemistry Today. The aim of Chemistry Musing is to augment the chances of bright students preparing for JEE (Main and Advanced) / NEET / AIIMS / JIPMER with additional study material. In every issue of Chemistry Today, 10 challenging problems are proposed in various topics of JEE (Main and Advanced) / NEET. The detailed solutions of these problems will be published in next issue of Chemistry Today.

The readers who have solved five or more problems may send their solutions. The names of those who send atleast five correct solutions will be published in the next issue. We hope that our readers will enrich their problem solving skills through "Chemistry Musing" and stand in better stead while facing the competitive exams.

JEE MAIN/NEET

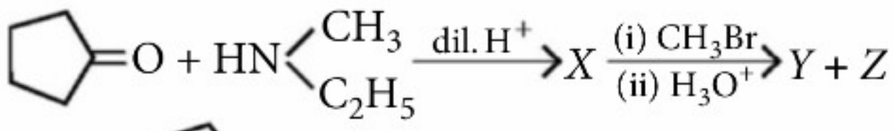
1. How long will it take for a uniform current of 6.00 A to deposit 78 g of gold from a solution of $AuCl_4^-$? What mass of chlorine gas will be formed simultaneously at anode of the cell?
(Atomic mass of Au = 197)

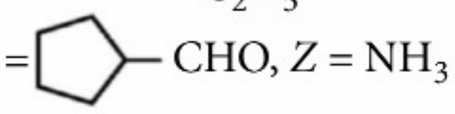
(a) $t = 3010$ sec, $w = 35.50$ g
(b) $t = 20306$ sec, $w = 45.54$ g
(c) $t = 19500$ sec, $w = 54.5$ g
(d) $t = 19139.16$ sec, $w = 42.24$ g

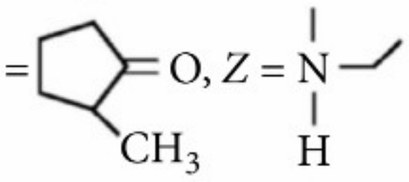
2. An electron, a proton and an alpha particle have kinetic energies of $16E$, $4E$ and E respectively. What is the qualitative order of their de Broglie wavelengths?

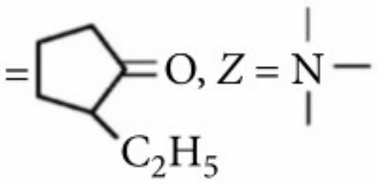
(a) $\lambda_e > \lambda_p = \lambda_\alpha$
(b) $\lambda_p = \lambda_\alpha > \lambda_e$
(c) $\lambda_p < \lambda_e > \lambda_\alpha$
(d) None of these

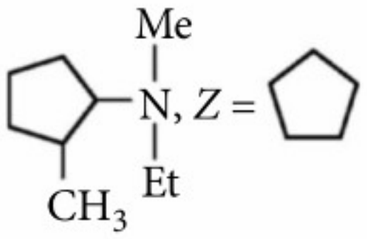
3. Identify Y and Z in the following sequence of reaction.



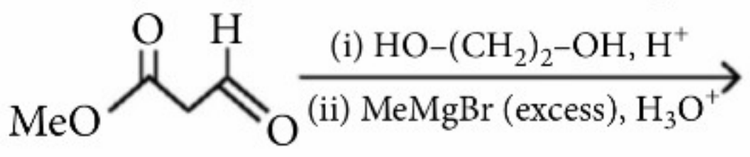
(a) $Y =$  $Z = NH_3$

(b) $Y =$  $Z =$

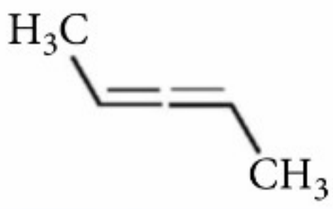
(c) $Y =$  $Z =$

(d) $Y =$  $Z =$

4. Identify the product of the following reaction.



5. Arrange the following in the order of their heat of hydrogenation, when all of them are converted to single *n*-pentane.

(i) 
(ii) 

WBJEE 2020 preponed to February 2 from April 19

WBJEE exam date for the 2020 session has been preponed by 10 weeks. Earlier, WBJEE exam date was April 19, 2020 but now it will take place on February 2, 2020. The West Bengal Joint Entrance Examination Board has decided to conduct the examination on the first Sunday of February every year said by the WBJEE Board chairman, Malayendu Saha. However, there is no such information available on the official website of WBJEE.

The proposal to conduct the WBJEE Exam ahead of the Higher Secondary Examinations had been sent to the state education minister Partha Chatterjee for approval. The reason to advance the examination date is to enroll more number of candidates in the engineering colleges of the state. In 2019, 18,000 seats out of 32,000 engineering seats remained vacant. The professors from some of the Universities have also suggested conducting the exam in February-March and declaring the result in April-May.

West Bengal Joint Entrance Examination Board conducts WBJEE every year to select the candidates for admission to the various BTech programs. WBJEE application form releases online and for this year it may release in the last week of December 2019. Candidates will get to know about the WBJEE dates after the release of the official notification. In order to fill the form, a candidate should meet the WBJEE eligibility criteria such as age limit, educational qualification, nationality, etc. WBJEE result will also release ahead of the Higher Secondary Examinations result and candidates who will qualify the exam with the minimum required percentage would apply for admission.

(iii) Me—≡—⌐Me (iv) Me⌐—≡CH

(a) (ii) > (iii) > (i) > (iv) (b) (i) > (iv) > (ii) > (iii)
(c) (iv) > (ii) > (i) > (iii) (d) (ii) > (iv) > (iii) > (i)

JEE ADVANCED

6. If same quantity of electricity is passed through three electrolytic cells containing $FeSO_4$, $Fe_2(SO_4)_3$ and $Fe(NO_3)_3$, then which of the following statements is/are incorrect?

(a) The amount of iron deposited in case of $FeSO_4$ and $Fe_2(SO_4)_3$ are equal.
(b) The amount of iron deposited in case of $FeSO_4$ is 1.5 times of the amount of iron deposited in case of $Fe(NO_3)_3$.
(c) The amount of iron deposited in case of $Fe_2(SO_4)_3$ and $Fe(NO_3)_3$ are equal.
(d) The amount of iron deposited in case of $FeSO_4$, $Fe_2(SO_4)_3$ and $Fe(NO_3)_3$ are same.

COMPREHENSION

Three types of pentane (C_5H_{12}) are available, *viz*, *n*-pentane, *iso*-pentane and *neo*-pentane. In the given table at 400 K, the standard enthalpy of formation and standard entropy of formation are given. Also consider these two quantities are independent on temperature.

Substances	$\Delta_f S°$(J $K^{-1}mol^{-1}$)	$\Delta_f H°$(kJ/mol)
n-pentane	360	–200
iso-pentane	340	–210
neo-pentane	300	–230
Hydrogen gas	130	—
Carbon solid (graphite)	6	—

7. The standard free energy of formation of *n*-pentane is

(a) –20 kJ/mol (b) –22 kJ/mol
(c) –26 kJ/mol (d) –18 kJ/mol

8. What is the equilibrium mole fraction of *neo*-pentane at 400 K in the natural pentane gas?

(a) $\dfrac{\frac{K_{eq_2}}{K_{eq_3}}+\frac{K_{eq_1}}{K_{eq_3}}}{1+\frac{K_{eq_2}}{K_{eq_3}}+\frac{K_{eq_1}}{K_{eq_3}}}$ (b) $\dfrac{1+\frac{K_{eq_1}}{K_{eq_3}}}{\frac{K_{eq_2}}{K_{eq_3}}+\frac{K_{eq_1}}{K_{eq_3}}+\frac{K_{eq_1}}{K_{eq_2}}}$

(c) $\dfrac{\frac{K_{eq_2}}{K_{eq_3}}}{1+\frac{K_{eq_2}}{K_{eq_3}}+\frac{K_{eq_1}}{K_{eq_2}}}$ (d) $\dfrac{1}{1+\frac{K_{eq_2}}{K_{eq_3}}+\frac{K_{eq_1}}{K_{eq_3}}}$

NUMERICAL VALUE

9. 1.0 g sample of Fe_2O_3 solid of 55.2% purity is dissolved in acid and reduced by heating the solution with zinc dust. The resultant solution is cooled and made upto 100 mL. An aliquot of 25.0 mL of this solution requires 17.0 mL of 0.0167 M solution of an oxidant for titration. The number of electrons taken up by the oxidant in the reaction of the above titration is

10. 1 mole of oxygen and 0.375 moles of solid A_4 are heated to react completely in a sealed vessel to produce only one gaseous compound *B*. After the formation of compound *B*, the vessel is brought to initial temperature, the pressure is found to be half of the initial pressure. The number of oxygen atoms per molecules of *B* is

Materials that can revolutionize how light is harnessed for solar energy !!

All modern solar panels operate by the same process -- one photon of light generates one exciton. Th exciton can then be converted into electric current. However, there are some molecules that can be implemented in solar cells that have the ability to generate two excitons from a single photon -- a process called singlet fission. These solar cells form the basis for next-generation devices, which are still at infancy.

In a study published recently, details the design of organic molecules that are capable of generating two excitons per photon of light. The excitons are produced rapidly and can live for much longer than those generated from their inorganic counterparts, which leads to an amplification of electricity generated per photon that is absorbed by a solar cell.

A new design rule for singlet fission materials has been developed. This has led to develop the most efficient and technologically useful intramolecular singlet fission materials to date. These improvements will open the door for more efficient solar cells.

CONCEPT BOOSTER

Hello everyone !! Hope you all had a lovely Durga puja, Dusshera, Kali puja, Deepawali and other festivals. I also believe that you continued your practice on your subjects. Coming back to CHEMISTRY, now it is the hard and perfect time that you become topic based and get into the depth as well as the surrounding areas of that. This is the only way you can master the subject. Keeping this in view. I have presented 'TITRATIONS' in this article. Hope you will enjoy reading it.

*Arunava Sarkar

In general, with the name 'Titrations' we do understand conductometric titrations, the basic principle of which is to replace one ion by the another where both have different ionic conductivities and as a result conductivity of the solution varies during the course of titration.

There are following types of titrations :

1. Acid-Base titration
2. Replacement titration
3. Redox titration
4. Precipitation titration

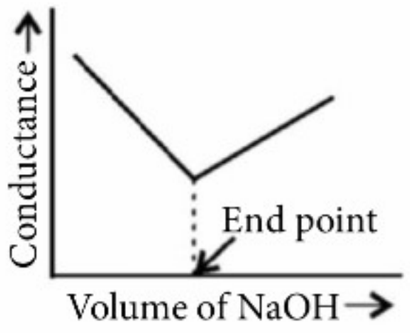
Acid-Base Titration

(a) Strong acid *vs* strong base

E.g., : HCl *vs* NaOH

Initially, conductance of HCl solution is high. High dissociation constant of HCl (K_a) and ionic mobility of H^+ (small size) are responsible for this.

Now, you add NaOH. OH^- combines with H^+ to give undissociated water (H_2O) molecules. H^+ is being replaced by Na^+. Conductance of the solution decreases and it continues upto equivalence point. Na^+ moves very slowly. At this point the solution contains only NaCl. If you add NaOH further then the solution contains more and more fast moving OH^- and conductance increases till NaOH is added.

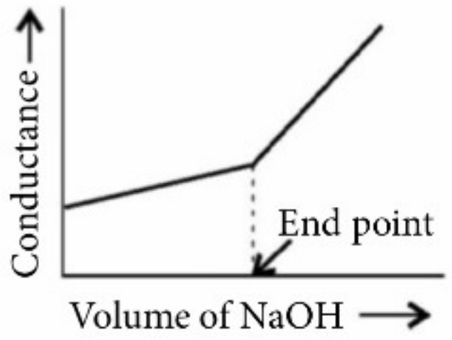


(b) Weak acid *vs* strong base

E.g., CH_3COOH *vs* NaOH

CH_3COOH has low K_a. So, initially conductance is poor. Addition of NaOH gives CH_3COONa, so fast moving H^+ being replaced by Na^+ which is slow moving. So conductance decreases. Another reason for decrease in the conductance is that due to common ion effect, dissociation of CH_3COOH further decreases. It is the initial scenario. Now if you add NaOH continuously, conductance will increase because NaOH will convert undissociated and weak electrolyte CH_3COOH into strong electrolyte CH_3COONa.

The increase in the conductance is maintained upto equivalence point and if beyond this point you continue adding NaOH then due to highly conducting OH^- ions, conductance continuously increases.



Graph near the equivalence point can be obtained by extrapolation method.

(c) Strong acid *vs* weak base

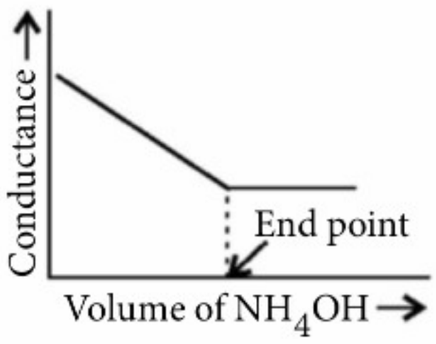
E.g., HCl *vs* NH_4OH

Monthly Test Drive CLASS XI ANSWER KEY

1. (d)	**2.** (d)	**3.** (a)	**4.** (c)	**5.** (c)
6. (b)	**7.** (b)	**8.** (c)	**9.** (d)	**10.** (b)
11. (d)	**12.** (c)	**13.** (a)	**14.** (a)	**15.** (a)
16. (a)	**17.** (c)	**18.** (c)	**19.** (c)	**20.** (b,d)
21. (a,c,d)	**22.** (a,c,d)	**23.** (b,d)	**24.** (1)	**25.** (2)
26. (4)	**27.** (a)	**28.** (b)	**29.** (a)	**30.** (b)

*Institute of Chemistry (IOC)- Asansol, Durgapur, Dhanbad, Burdwan, Kolkata, Jamshedpur, Bokaro, Patna

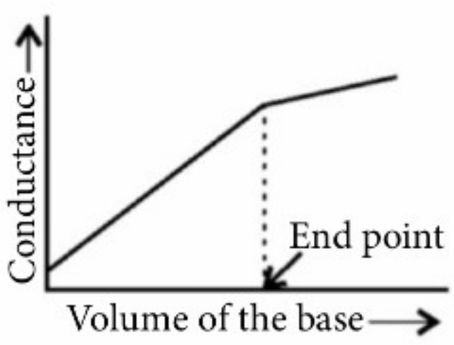
Initially conductance was high due to high dissociation constant of HCl and fast moving H^+ ions. On addition of NH_4OH, NH_4Cl starts producing *i.e.*, fast moving H^+ being replaced by NH_4^+ (slow moving). This decrease in conductance continues upto equivalence point. Beyond this point even after the addition of NH_4OH conductance nearly remains the same as NH_4OH is weak base and it dissociates to very small extent. Moreover, due to common ion effect, dissociation even more decreases.



(d) Weak acid *vs* weak base :

E.g., CH_3COOH *vs* NH_4OH

Initial nature of curve remains same as that of weak acid *vs* strong base. Because, CH_3COOH is almost an undissociated molecule but after the addition of NH_4OH, it gives CH_3COONH_4 and it is strongly ionizable though complete replacement is never happening here as both CH_3COOH and NH_4OH are weakly ionizable. After the equivalence point, conductance remain nearly same as due to the weak nature and common ion effect, NH_4OH remains almost undissociated.



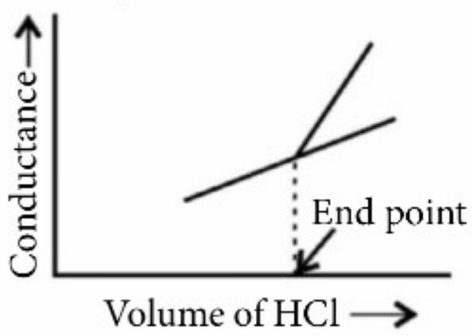
Displacement or Replacement Titration

Let the titration happen between salt of weak acid and strong acid. The anion of weak acid is replaced by that of strong acid and the weak acid is liberated in undissociated form.

E.g., $CH_3COO\overset{-}{N}a^+ + HCl \longrightarrow CH_3COOH + \overset{+}{N}aCl^-$

acetate ion (anion of weak acid) — chloride ion (anion of strong acid)

In the above example, initially conductance increases as Cl^- ions are slightly fast moving than CH_3COO^-. Till the equivalence point don't expect the ionization of CH_3COOH as enough CH_3COONa remains in the solution to suppress the ionization of CH_3COOH. After equivalence point CH_3COOH is ionized to a good extent and affect the conductivity and a rounded portion in curve is obtained. Beyond equivalence point, when excess of HCl is added, conductivity increases rapidly as HCl is strong electrolyte.



UNSCRAMBLE ME

Unscramble the words given in column I and match them with their explanations in column II.

Column I	Column II
1. GSIRIDREV	(a) The non-sugar compound remaining after replacement of the glycosyl group from a glycoside by a hydrogen atom.
2. TTAGNREOE	(b) A precipitate that has aggregated in wooly masses.
3. ONYLCGA	(c) Greenish basic salts of copper. Basic copper acetate is a true example of this.
4. RAFEINRRNST	(d) Pharmaceutical solutions, frequently containing alcohols, used as a sweetening or flavouring agents for drugs.
5. ELTNCCOLFU	(e) A chemical which produces malfunction, generally in the form of mutations or tumours.
6. RSIXILE	(f) Polysaccharides generally containing galacturonic acid, xylose and arabinose residues which swells in water.
7. FERIIRALC	(g) A protein which is main mode of transport of iron.
8. ESGALICUM	(h) Large tanks with continuous feed and outflow in which the suspended matter is allowed to settle and is removed.

Readers can send their responses at editor@mtg.in or post us with complete address by 10th of every month.
Names of solution senders will be published in next issue.

Rank Enhancer

This column is specially designed to make your concepts crystal clear.

EQUIVALENT FACTOR (*n*-FACTOR)

For Acids

Equivalent factor (*n*-factor) = Number of replaceable or ionisable H^+

Examples : For $HCl \longrightarrow H^+ + Cl^-$ $\therefore$ *n*-factor = 1

For $H_2SO_4 \longrightarrow 2H^+ + SO_4^{2-}$ $\therefore$ *n*-factor = 2

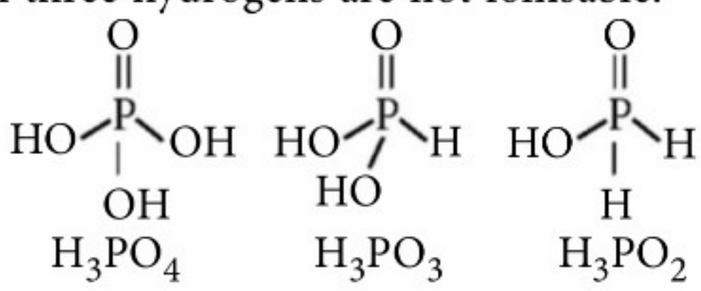
For $H_3PO_4 \longrightarrow 3H^+ + PO_4^{3-}$ $\therefore$ *n*-factor = 3

For $(COOH)_2$ or $H_2C_2O_4 \longrightarrow 2H^+ + C_2O_4^{2-}$

$\therefore$ *n*-factor = 2

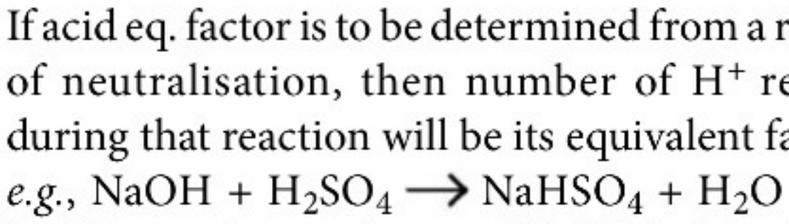
Noteworthy points :

- For H_3PO_3 and H_3PO_2 equivalent factor is "Not" 3. Since all three hydrogens are not ionisable.



	H_3PO_4	H_3PO_3	H_3PO_2
No. of H-attached to oxygen	3	2	1
$\therefore$ Eq. factor	3	2	1

- If acid eq. factor is to be determined from a reaction of neutralisation, then number of H^+ replaced during that reaction will be its equivalent factor.
  e.g., $NaOH + H_2SO_4 \longrightarrow NaHSO_4 + H_2O$
  In this reaction eq. factor of H_2SO_4 is 1 but NOT 2
  Similarly, for
  $H_3PO_4 + 2NaOH \longrightarrow Na_2HPO_4 + 2H_2O$
  In this reaction, eq. factor of H_3PO_4 is 2 but NOT 3.
- In H_3BO_3 even though, all 'H' atoms are directly attached to oxygen but they are not ionisable. Since it is a electron deficient molecule and H_3BO_3 is Lewis acid. It gains OH^- from water molecule and looses remaining H^+. Therefore, eq. factor is 1.



For Bases

Eq. factor = Number of replaceable OH^- or hydroxyl ions lost.

Examples : $NaOH \longrightarrow Na^+ + OH^-$ Eq. factor = 1

$Ca(OH)_2 \longrightarrow Ca^{2+} + 2OH^-$ Eq. factor = 2

$NH_4OH \longrightarrow NH_4^+ + OH^-$ Eq. factor = 1

For Salts

Total +ve charge (or) total –ve charge = Eq. factor

Examples : $NaNO_3 \longrightarrow Na^+ + NO_3^-$ Eq. factor = 1

$Ca_3(PO_4)_2 \longrightarrow 3Ca^{2+} + 2PO_4^{3-}$ Eq. factor = $2 \times 3 = 6$

$AlPO_3 \longrightarrow Al^{3+} + PO_3^{3-}$ Eq. factor = $1 \times 3 = 3$

For Elementary Ions

Equivalent factor = Charge

Ferrous ion $\Rightarrow Fe^{2+}$ Eq. factor = 2

Ferric ion $\Rightarrow Fe^{3+}$ Eq. factor = 3

Cuprous ion $\Rightarrow Cu^+$ Eq. factor = 1

Cupric ion $\Rightarrow Cu^{2+}$ Eq. factor = 2

For Complex Ions

Equivalent factor = Charge

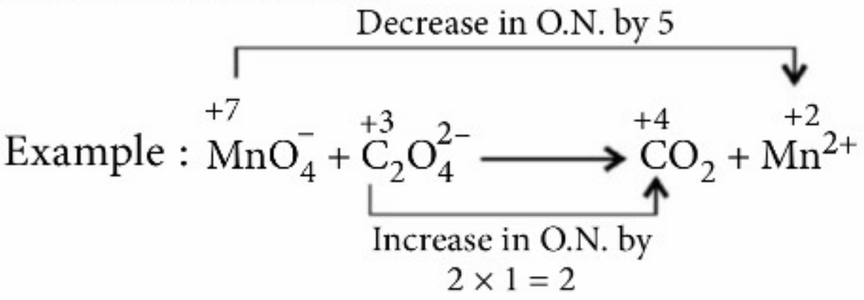
Sulphate ion $\Rightarrow SO_4^{2-}$ Eq. factor = 2

Dichromate ion $\Rightarrow Cr_2O_7^{2-}$ Eq. factor = 2

Phosphate ion $\Rightarrow PO_4^{3-}$ Eq. factor = 3

In Redox Reactions

Eq. factor = Increase in oxidation number (or) decrease in oxidation number



In the above redox reaction :

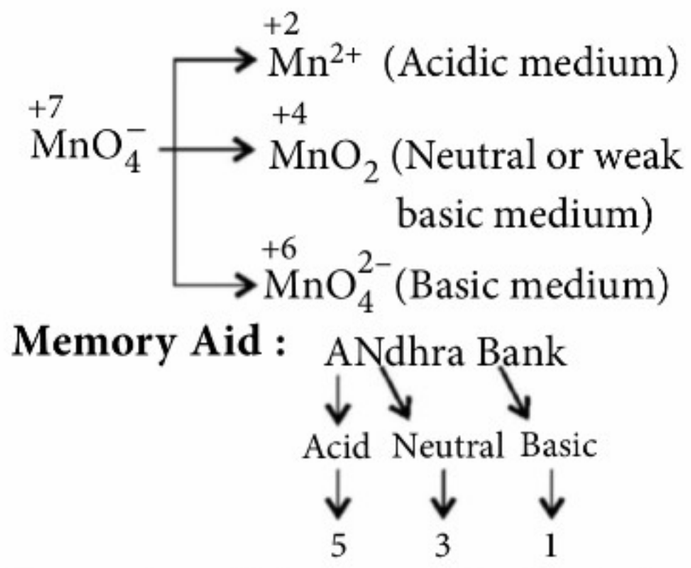
(a) Oxidation number of Mn in of MnO_4^- changes from +7 to +2. Hence eq. factor of MnO_4^- is = 5

(b) Oxidation number of each 'C' atom changes from +3 to +4 and in two C atom per ion. Hence equivalent factor of $C_2O_4^{2-} = 2 \times 1 = 2$

Some Specially Used Substances with Their Eq. Factors

- **Potassium permanganate ($KMnO_4$)** : It can act as an oxidising agent in all three mediums *i.e.*, acidic, basic and neutral medium. But eq. factor is different in different mediums.

By K. Vijay Bhasker, Senior faculty at Sri Chaitanya Educational Institution, Visakhapatnam

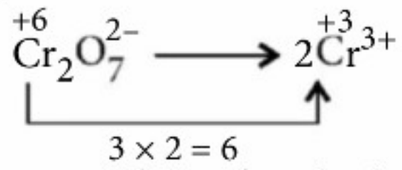


Memory Aid : ANdhra Bank

Acid Neutral Basic

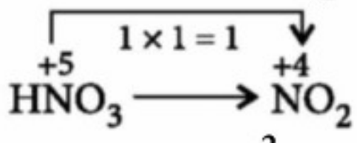
5 3 1

- **Potassium dichromate ($K_2Cr_2O_7$) :** It is powerful oxidising agent but limited to acidic medium only.



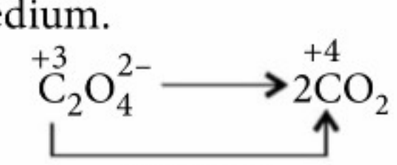
∵ Oxidation number of each chromium changes from +6 to +3 and in two Cr per ion. Hence eq. factor = 6

- **Conc. HNO_3 :** It is a strong oxidising agent and reduces itself into NO_2.



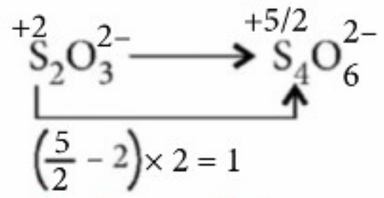
Eq. factor = 1

- **Oxalate ion ($C_2O_4^{2-}$) :** It is a reducing agent in all medium.



Eq. factor = 2

- **Hypo ($Na_2S_2O_3 \cdot 2H_2O$) :** Sodium ion in hypo is just spectator ion and $S_2O_3^{2-}$ (thiosulphate ion) acts as reducing agent.



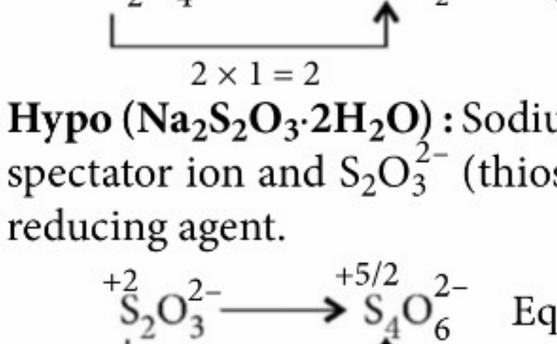
Eq. factor = 1

Some Useful Conditions of Redox Reactions

- **Condition-I :** When only one element of molecule/ion undergoes oxidation/reduction

Eq. factor = Change in oxidation number of element

Examples :



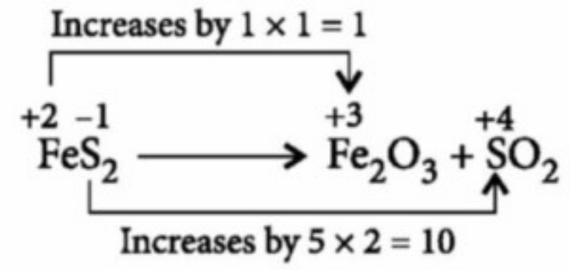
- **Condition -II :** When two or more elements undergo either oxidation or reduction

Eq. factor = Sum of increase in oxidation number of all elements (in case of oxidation).

or

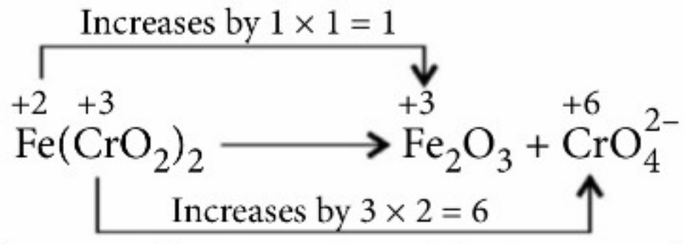
Sum of decrease in oxidation number of all elements (in case of reduction).

Examples : (a)



Eq. factor = Increase in oxidation number of Fe + increase in oxidation number of S = 1 + 10 = 11

(b)

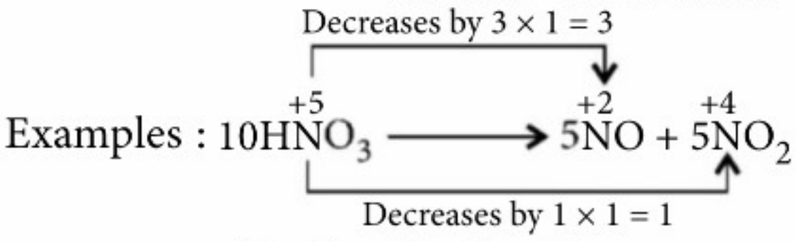


Eq. factor = Increase in oxidation number of Fe + Increase in oxidation number of Cr = 1 + 6 = 7

- **Condition-III :** When same element appears in two or more different products with different increase/decrease of oxidation number,

$$\text{Eq. Factor} = \frac{\text{Net increase/decrease in all molecules}}{\text{Number of molecules}}$$

Examples :

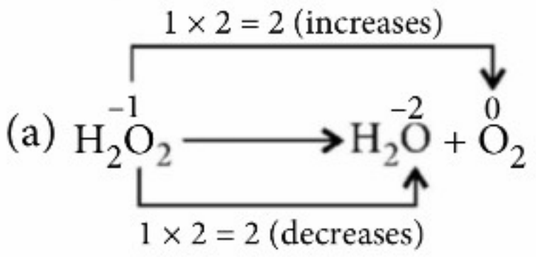


$$\text{Eq. factor} = \frac{(5\times 3)+(5\times 1)}{10} = \frac{20}{10} = 2$$

- **Condition-IV :** When same element undergo oxidation and reduction to give different products (Disproportionation reaction)

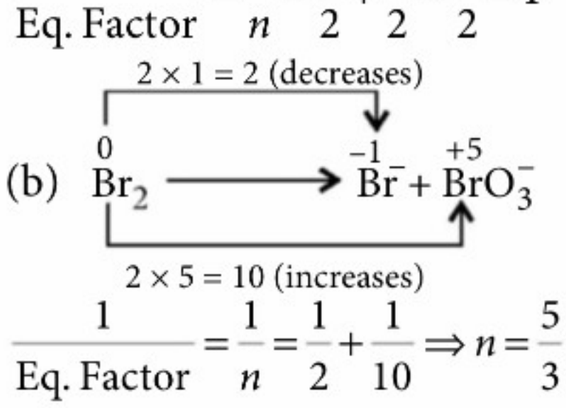
Examples :

(a)



$$\frac{1}{\text{Eq. Factor}} = \frac{1}{n} = \frac{1}{2} + \frac{1}{2} = \frac{2}{2} = 1$$

(b)

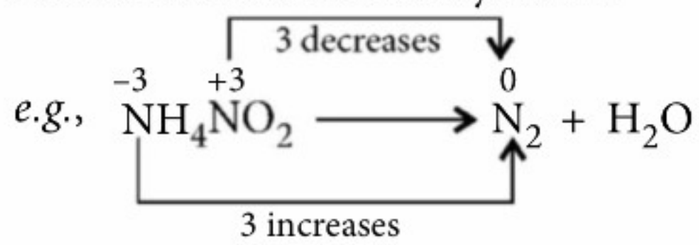


$$\frac{1}{\text{Eq. Factor}} = \frac{1}{n} = \frac{1}{2} + \frac{1}{10} \Rightarrow n = \frac{5}{3}$$

- **Condition V :** When same element in different part of salt reaches to same final oxidation state (Comproportionation reaction),

Eq. factor = Eq. factor of oxidation or eq. factor of reduction

Note : Both will be always same



∴ Eq. factor = 3

QUESTIONS FOR PRACTICE

Single Option Correct Type

1. Eq. factor of cuprous sulphide in following reaction is

$Cu_2S + KMnO_4 \longrightarrow Mn^{2+} + Cu^{2+} + SO_2$

(a) 2 (b) 4 (c) 6 (d) 8

2. If on reaction between 2.68×10^{-3} moles of A^{x+} and 1.61×10^{-3} moles of MnO_4^-, AO_3^- and Mn^{2+} are produced. Find nearest rounded value of x

(a) 2 (b) 3 (c) 1 (d) 6

3. Eq. factor of phosphorus in the reaction:

$P_4 + NaOH \longrightarrow NaH_2PO_2 + PH_3$

(a) 6 (b) 9 (c) 3 (d) 12

4. In which medium, $KMnO_4$ has lowest eq. weight?

(a) Acidic (b) Neutral
(c) Weakly basic (d) Basic

5. Eq. factor of Cr in following reaction is

$CrO_5 + H_2SO_4 \longrightarrow Cr_2(SO_4)_3 + H_2O + O_2$

(a) 2 (b) 7 (c) 3 (d) 9

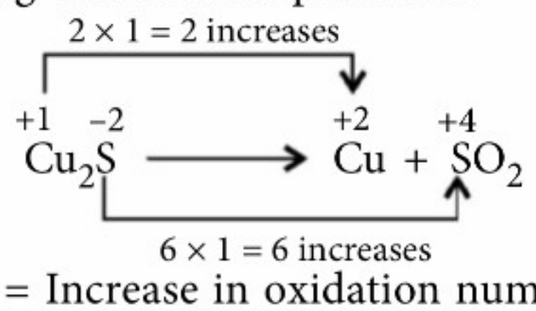
Matching List Type

6. Match the following :

Reactions		Eq. factor	
(1)	$As_2S_3 \longrightarrow AsO_4^{3-} + SO_4^{2-}$	A.	28
(2)	$CrI_3 \longrightarrow CrO_7^{2-} + IO_4^-$	B.	33
(3)	$NH_4SCN \longrightarrow NO_3^- + SO_4^{2-} + CO_3^{2-}$	C.	27
(4)	$Fe(SCN)_2 \longrightarrow Fe^{3+} + NO_3^- + CO_3^{2-} + SO_4^{2-}$	D.	24

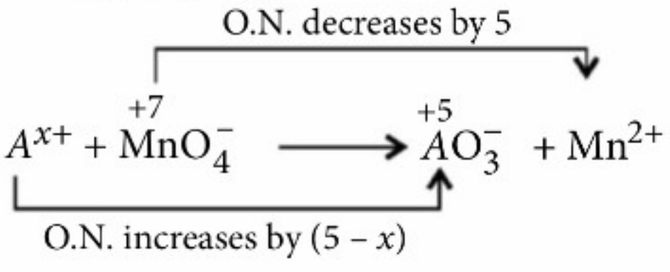
Hints & Solutions

1. (d) : Using condition-II procedure



∴ n-factor = Increase in oxidation number of Cu + increase in oxidation number of S

= 2 + 6 = 8



2. (a) :

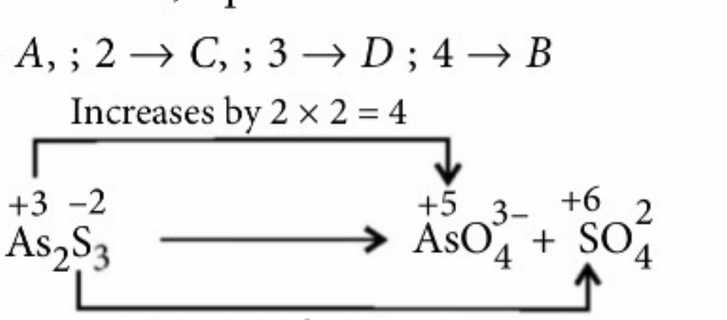
For complete reaction, both equivalents must be same.

∴ Equivalents of A^{x+} = Equivalents of MnO_4^-

(No. of moles × eq. factor)$_{A^{x+}}$ = (No. of moles × eq. factor)$_{MnO_4^-}$

$2.68 \times 10^{-3} \times (5 - x) = 1.61 \times 10^{-3} \times 5$; $x = 2$

3. (c) :

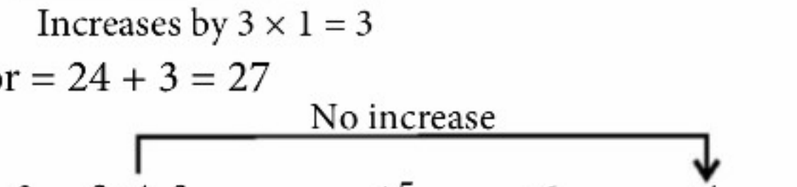


Using condition-IV,

$$\frac{1}{\text{Eq. factor }(n)} = \frac{1}{4} + \frac{1}{12}, \quad \frac{1}{n} = \frac{12+4}{4\times12} \Rightarrow n = 3$$

4. (a) : For lowest eq. wt., eq. factor must be highest which is found in acidic medium (eq. factor = 5).

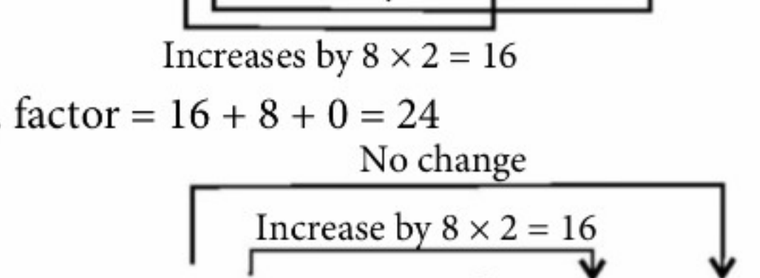
5. (c) :



Using condition-I, eq. factor = 3 × 1 = 3

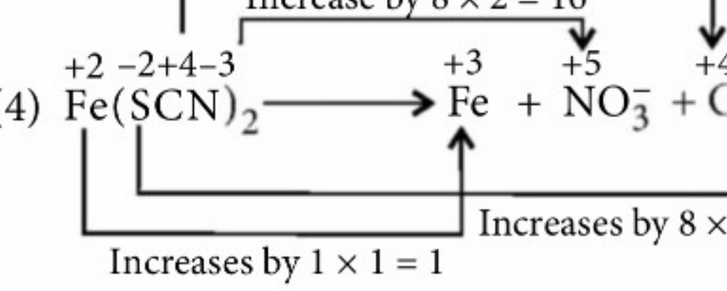
6. $1 \rightarrow A$, ; $2 \rightarrow C$, ; $3 \rightarrow D$; $4 \rightarrow B$

(1)



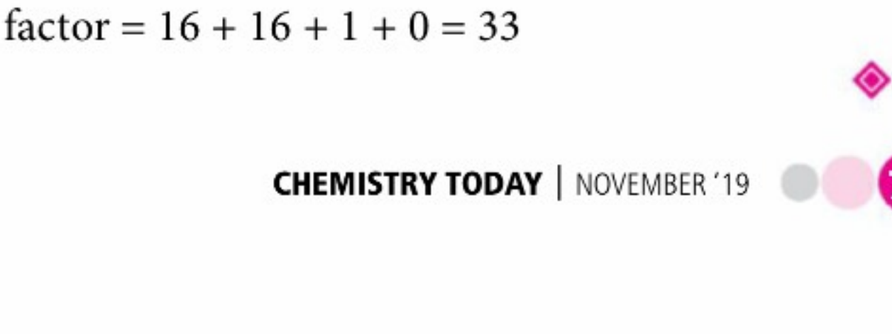
Eq. factor = 4 + 24 = 28

(2)



Eq. factor = 24 + 3 = 27

(3)



Eq. factor = 16 + 8 + 0 = 24

(4)

Eq. factor = 16 + 16 + 1 + 0 = 33

GEAR UP FOR JEE MAIN 2020

Between 6th to 11th January, 2020

with Numerical Value Type Questions

1. The values of x, y and z in the following reaction are respectively

$$xMnO_4^- + yH^+ + zNO_2^- \longrightarrow xMn^{2+} + \frac{y}{2}H_2O + zNO_3^-$$

(a) 6, 2, 5 (b) 5, 2, 6 (c) 2, 5, 6 (d) 2, 6, 5

2. $X + Y \xleftarrow[(i)]{CN^-} CH_3-CH=CH-CH_2Cl \xrightarrow[(ii)]{CN^-} X$

The types of the reactions (i) and (ii) are respectively

(a) S_N2, S_N1 (b) E1, E2
(c) S_N1, S_N2 (d) E2, E1

3. A dust particle has mass equal to 10^{-11} g, diameter 10^{-4} cm and velocity 10^{-4} cm s^{-1}. If the error in measurement of velocity is 0.1% then the uncertainty in its position is

(a) 5.27×10^{-10} cm (b) 5.27×10^{-6} m
(c) 5.27×10^{-6} cm (d) 5.27×10^{-10} m

4. A sample of wustite contains one Fe (III) for every three Fe (II). The amount of oxygen atoms (in moles) is

(a) $\frac{9}{4}$ (b) $\frac{8}{9}$ (c) $\frac{4}{9}$ (d) $\frac{9}{8}$

5. $Be_2C + H_2O \longrightarrow BeO + X$

$CaC_2 + H_2O \longrightarrow Ca(OH)_2 + Y$

$Mg_2C_3 + H_2O \longrightarrow Mg(OH)_2 + Z$

X, Y and Z are respectively

(a) CH_4, C_2H_2, C_3H_8 (b) CH_4, C_2H_6, C_3H_8
(c) CH_4, C_2H_2, C_3H_4 (d) C_2H_2, C_2H_6, C_3H_4

6. At 20°C, the osmotic pressure of urea solution is 400 mm. If the solution is diluted and the temperature is raised to 35°C, then the osmotic pressure is found to be 105.3 mm. The solution is diluted to

(a) 6 times (b) 4 times
(c) 2 times (d) 8 times.

7. The reaction, $2AB_{(g)} + 2C_{(g)} \longrightarrow A_{2(g)} + 2BC_{(g)}$ proceeds according to the mechanism :

(I) $2AB \rightleftharpoons A_2B_2$ (fast)

(II) $A_2B_2 + C \longrightarrow A_2B + BC$ (slow)

(III) $A_2B + C \longrightarrow A_2 + BC$ (fast)

What will be the initial rate taking $[AB] = 0.2$ M and $[C] = 0.5$ M? The K_c for the step I is 10^2 M^{-1} and rate constant for the step II is 3.0×10^{-3} mol^{-1} L min^{-1}.

(a) 0.0716 M min^{-1} (b) 0.0891 M min^{-1}
(c) 0.006 M min^{-1} (d) 0.0257 M min^{-1}

8. The salt which is least likely to be found as mineral is

(a) chloride (b) sulphate
(c) sulphide (d) nitrate.

9. $E°_{red}$ of different half-cells are given :

$E°_{Cu^{2+}/Cu} = 0.34$ V; $E°_{Zn^{2+}/Zn} = -0.76$ V;
$E°_{Ag^+/Ag} = 0.80$ V; $E°_{Mg^{2+}/Mg} = -2.37$ V

In which cell is $\Delta G°$ most negative?

(a) $Zn \mid Zn^{2+}$ (1 M) $\mid\mid Mg^{2+}$ (1 M) $\mid Mg$
(b) $Zn \mid Zn^{2+}$ (1 M) $\mid\mid Ag^+$ (1 M) $\mid Ag$
(c) $Cu \mid Cu^{2+}$ (1 M) $\mid\mid Ag^+$ (1 M) $\mid Ag$
(d) $Ag \mid Ag^+$ (1 M) $\mid\mid Mg^{2+}$ (1 M) $\mid Mg$

10. In context with the transition elements, which of the following statements is incorrect?

(a) In addition to the normal oxidation states, the zero oxidation state is also shown by these elements in complexes.
(b) In the highest oxidation states, the transition metals show basic character and form cationic complexes.
(c) In the highest oxidation states of the first five transition elements (Sc to Mn), all the 4s and 3d electrons are used for bonding.
(d) Once the d^5 configuration is exceeded, the tendency to involve all the 3d electrons in bonding decreases.

11. Identify the correct statement.

(a) Bond order of N_2^+ is more than that of N_2 whereas in O_2^+ it is less than O_2.
(b) Bond order of N_2^+ is equal to that of N_2 whereas in O_2^+ it is more than O_2.
(c) Bond order of N_2^+ is less than that of N_2 whereas in O_2^+ it is more than O_2.
(d) Bond order of N_2^+ is less than that of N_2 whereas in O_2^+ it is equal to that of O_2.

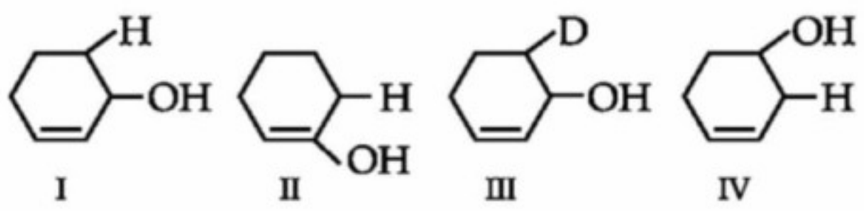
12. Among CH_4, SiH_4, GeH_4 and SnH_4, which one is most volatile?

(a) CH_4 (b) SiH_4 (c) GeH_4 (d) SnH_4

13. A gas '*X*' is passed through water to form a saturated solution. The aqueous solution on treatment with silver nitrate gives a white precipitate. The saturated aqueous solution also dissolves magnesium ribbon with evolution of a colourless gas '*Y*'. '*X*' and '*Y*' respectively are

(a) CO_2, Cl_2 (b) Cl_2, CO_2
(c) Cl_2, H_2 (d) H_2, Cl_2

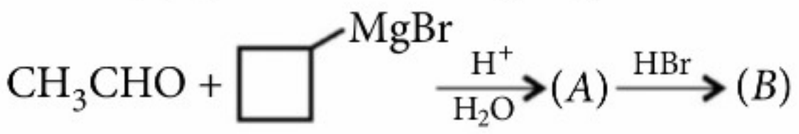
14. The ease of dehydration in the following compounds is

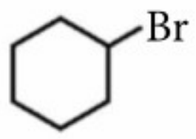


I II III IV

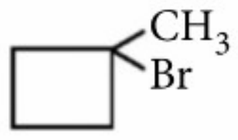
(a) I > III > IV > II (b) II > I > III > IV
(c) IV > I > III > II (d) III > I > II > IV

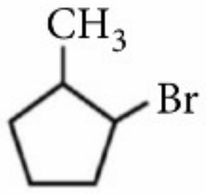
15. Identify (*B*) in the following sequence of reaction,



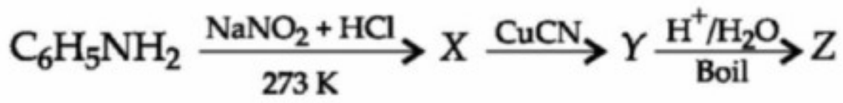
(a) 

(b) 

(c) 

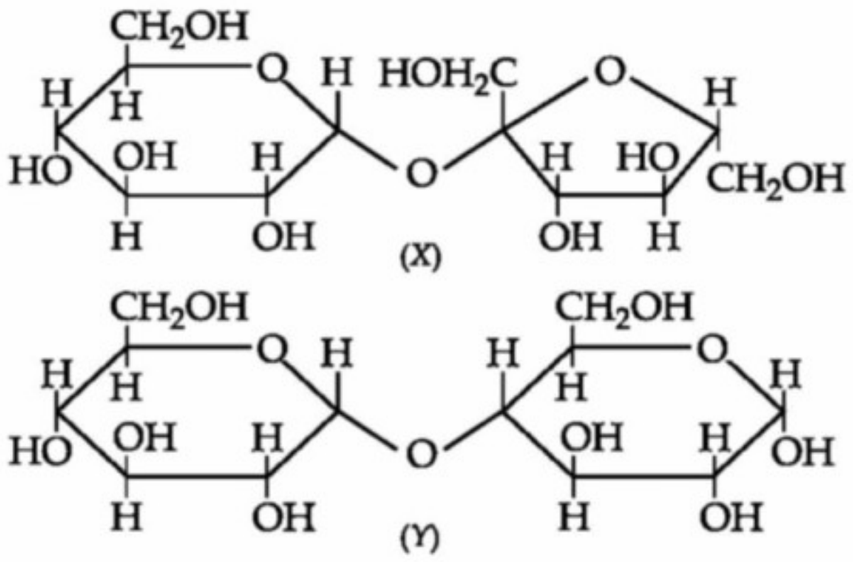
(d) 

16. Identify the '*Z*' in the following sequence of reaction.



(a) C_6H_5CN (b) $C_6H_5CONH_2$
(c) C_6H_5COOH (d) $C_6H_5CH_2NH_2$

17. Which of the following will not reduce Tollens' reagent?



(a) (*X*) only (b) (*Y*) only
(c) Both (*X*) and (*Y*) (d) Neither (*X*) nor (*Y*)

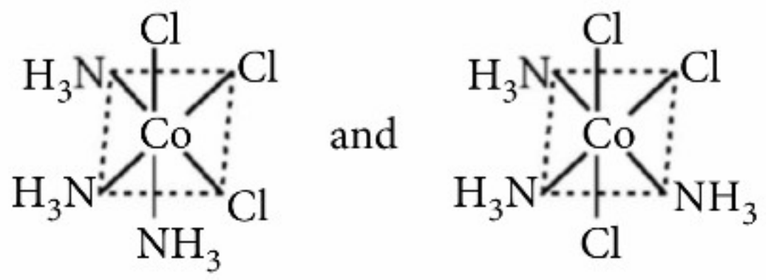
18. Amoxicillin is semi-synthetic modification of

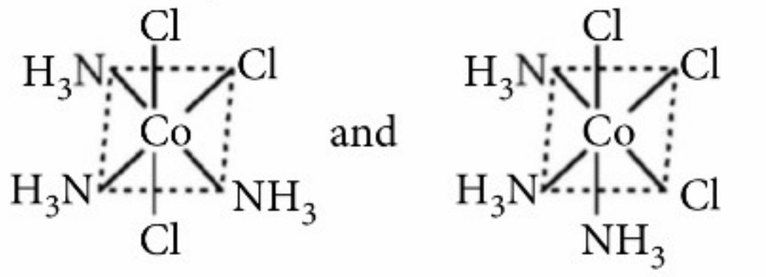
(a) penicillin (b) streptomycin
(c) tetracycline (d) chloramphenicol.

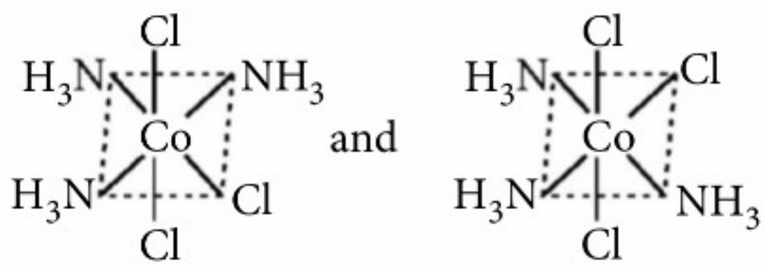
19. The bond enthalpy of $H_{2(g)}$ is 436 kJ mol^{-1} and that of $N_{2(g)}$ is 941.3 kJ mol^{-1}. Calculate the average bond enthalpy of an N—H bond in ammonia if $\Delta H^\circ_f(NH_3) = -46.0$ kJ mol^{-1}.

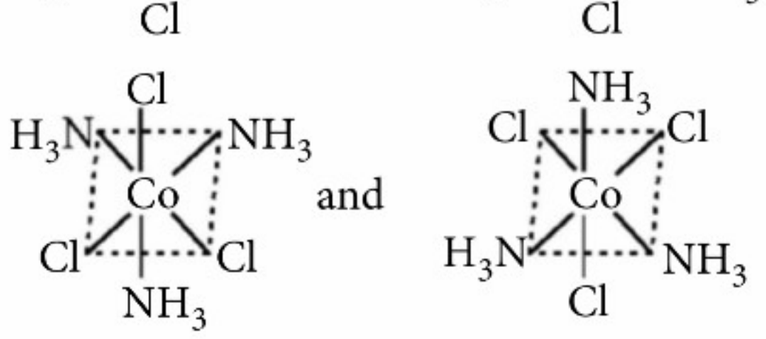
(a) 443.67 kJ mol^{-1} (b) 474.33 kJ mol^{-1}
(c) 390.2 kJ mol^{-1} (d) 244.88 kJ mol^{-1}

20. Which of the following pairs of structures represents facial and meridional isomers respectively?

(a) 

(b) 

(c) 

(d) 

Numerical Value Type

21. Density of Li atom is 0.53 g/cm^3. The edge length of Li is 3.5 Å. The number of Li atoms in a unit cell is _____ . (Given : $N_0 = 6.023 \times 10^{23}$, $M = 6.94$)

22. A flask contains a mixture of compounds *A* and *B*. Both compounds decompose by first-order kinetics. The half-lives are 54.0 min for *A* and 18.0 min for *B*. If the concentrations of *A* and *B* are equal initially, the time taken (in min) for the concentration of *A* to be four times that of *B* will be _____ .

23. An evacuated glass vessel weighs 50.0 g when empty, 148.0 g when filled with a liquid of density 0.98 g mL^{-1} and, 50.5 g when filled with an ideal gas at 760 mm Hg at 300 K. The molar mass of the gas is _____ .

24. The equilibrium constants at 1395 K for the following reactions are :

$2H_2O_{(g)} \rightleftharpoons 2H_{2(g)} + O_{2(g))}$; $K_1 = 2.1 \times 10^{-13}$

$2CO_{2(g)} \rightleftharpoons 2CO_{(g)} + O_{2(g)}$; $K_2 = 1.4 \times 10^{-12}$

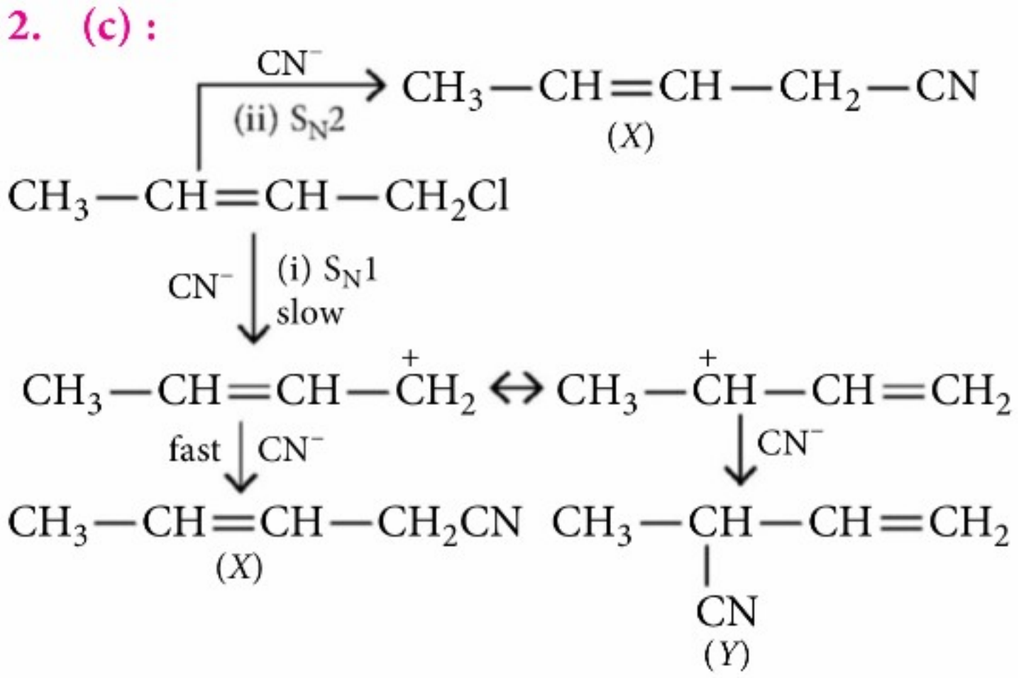
The equilibrium constant for the reaction $H_{2(g)} + CO_{2(g)} \rightleftharpoons H_2O_{(g)} + CO_{(g)}$ at 1395 K is _____ .

25. *n*-Butane is produced by monobromination of ethane (in 2) followed by the Wurtz reaction. If the bromination takes place with 90% yield and the Wurtz reaction with 85% yield, the volume of ethane (in L) at NTP required to produce 55 g *n*-butane is _____ .

SOLUTIONS

1. (d) : $2MnO_4^- + 6H^+ + 5NO_2^- \longrightarrow 2Mn^{2+} + 3H_2O + 5NO_3^-$

2. (c) :



3. (c) : Applying uncertainty principle,

$$\Delta v = \frac{10^{-4} \times 0.1}{100} = 1 \times 10^{-7} \text{ cm s}^{-1}$$

As $\Delta x \times \Delta v = \frac{h}{4\pi m}$

$$\therefore \Delta x = \frac{6.626 \times 10^{-27}}{4 \times 3.14 \times 10^{-11} \times 1 \times 10^{-7}} = 5.27 \times 10^{-10} \text{ cm}$$

Uncertainty in position as compared to particle size

$$= \frac{\Delta x}{\text{diameter}} = \frac{5.27 \times 10^{-10}}{10^{-4}} = 5.27 \times 10^{-6} \text{ cm}$$

4. (d) : Let there be 1 mol of iron atom.

Amount of Fe (III) $= \left(\frac{1}{4}\right)$ mol ;

Amount of Fe (II) $= \left(\frac{3}{4}\right)$ mol

Total moles of positive charge

$$= \left(\frac{1}{4}\right)(+3) + \left(\frac{3}{4}\right)(+2) = \left(\frac{9}{4}\right) \text{mol}$$

Let x be the amount of oxygen atoms.

Total moles of negative charge $= 2x$

To satisfy electrical neutrality,

Total moles of positive charge = Total moles of negative charge

or, $\frac{9}{4}$ mol $= 2x \Rightarrow x = \frac{9}{8}$ mol

5. (c)

6. (b) : $\pi = \frac{400}{760}$ atm, $T = 293$ K

Now using, $\pi V = nRT$

$$\frac{400}{760} \times V_1 = n \times R \times 293 \qquad \ldots(i)$$

After dilution, let volume becomes V_2 and temperature is raised to 35°C, *i.e.*, 308 K, and

osmotic pressure changes to, $\pi = \frac{105.3}{760}$ atm, then

$$\frac{105.3}{760} \times V_2 = n \times R \times 308 \qquad \ldots(ii)$$

Dividing eqn. (i) by (ii), we get

$$\frac{V_1}{V_2} = \frac{293}{308} \times \frac{105.3}{400} \Rightarrow V_2 = 4V_1$$

Hence, the solution is diluted to 4 times.

7. (c) : Rate of reaction = Rate of step II (the slowest step)

$\Rightarrow$ Rate of reaction $\propto [A_2B_2][C] = k[A_2B_2][C]$ ...(i)

where k is the rate constant, of step II.

The equilibrium constant, K_c for the step I is

$$K_c = \frac{[A_2B_2]}{[AB]^2} \Rightarrow [A_2B_2] = K_c[AB]^2$$

Putting this in equation (i), we get

Rate of reaction $= k \cdot K_c[AB]^2[C] = k'[AB]^2[C]$

$\propto [AB]^2[C]$ ...(ii)

where $k' = k \cdot K_c$ = rate constant of reaction.

Equation (ii) is the rate law of reaction,

initial rate $= 3.0 \times 10^{-3} \times 10^2 \times (0.2)^2(0.5)$

$= 0.3 \times 0.04 \times 0.5 = 0.006$ M min^{-1}

8. (d) : Nitrate is least likely to be found as mineral.

9. (b) : (a) Zn | Zn^{2+} (1 M) | | Mg^{2+} (1 M) | Mg

$E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode} = E^\circ_{Mg^{2+}/Mg} - E^\circ_{Zn^{2+}/Zn}$

$= -2.37 - (-0.76) = -1.61$ V

$\Delta G^\circ = -nFE^\circ_{cell} = -2 \times 96500 \times (-1.61) = +310{,}730$ J mol^{-1}

(b) Zn | Zn^{2+} (1 M) | | Ag^+ (1 M) | Ag

$E^\circ_{cell} = E^\circ_{Ag^+/Ag} - E^\circ_{Zn^{2+}/Zn} = 0.80 - (-0.76) = +1.56$ V

$\Delta G^\circ = -nFE^\circ_{cell} = -2 \times 96500 \times 1.56 = -301{,}080$ J mol^{-1}

(c) Cu | Cu^{2+} (1 M) | | Ag^{+} (1 M) | Ag

$E^\circ_{cell} = E^\circ_{Ag^+/Ag} - E^\circ_{Cu^{2+}/Cu} = 0.80 - 0.34 = +0.46$ V

$\Delta G^\circ = -nFE^\circ_{cell} = -2 \times 96500 \times 0.46 = -88{,}780$ J mol^{-1}

(d) Ag | Ag^{+} (1 M) | | Mg^{2+} (1 M) | Mg

$E^\circ_{cell} = E^\circ_{Mg^{2+}/Mg} - E^\circ_{Ag^+/Ag} = -2.37 - 0.80 = -3.17$ V

$\Delta G^\circ = -nFE^\circ_{cell} = -2 \times 96500 \times (-3.17) = +611{,}810$ J mol^{-1}

10. (b) : When the transition metals are in their highest oxidation state, they no longer have tendency to give away electrons, they are not basic but show acidic character and form anionic complexes.

11. (c) : N_2^+ is formed by the removal of an electron from the bonding $\sigma 2p_z$ molecular orbital which causes the reduction in the bond order in N_2^+, it becomes 2.5 in N_2^+ from 3 in N_2.

$N_2^+ : \sigma 1s^2\ \sigma^* 1s^2\ \sigma 2s^2\ \sigma^* 2s^2\ \pi 2p_x^2\ \pi 2p_y^2\ \sigma 2p_z^1$

$$\text{Bond order of } N_2^+ = \frac{N_b - N_a}{2} = \frac{9-4}{2} = 2.5$$

But O_2^+ is formed by the removal of an electron from the antibonding ($\pi^* 2p_x$) or ($\pi^* 2p_y$) molecular orbital which causes an increase in the bond order in O_2^+, it becomes 2.5 from 2 in O_2.

$O_2^+ : \sigma 1s^2\ \sigma^* 1s^2\ \sigma 2s^2\ \sigma^* 2s^2\ \sigma 2p_z^2\ \pi 2p_x^2\ \pi 2p_y^2\ \pi^* 2p_x^1$

$$\therefore \quad \text{Bond order of } O_2^+ = \frac{N_b - N_a}{2} = \frac{10-5}{2} = 2.5$$

12. (a) : CH_4 is most volatile due to lower molecular mass.

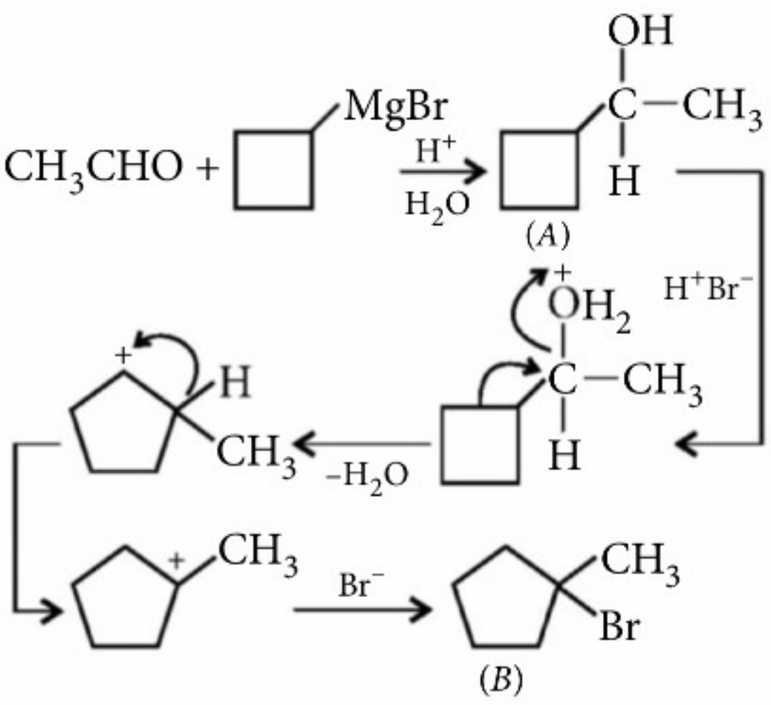
13. (c) : $\underset{(X)}{Cl_2\uparrow} + H_2O \longrightarrow HClO + HCl$

$AgNO_3 + HCl \longrightarrow \underset{\text{White ppt.}}{AgCl\downarrow} + HNO_3$

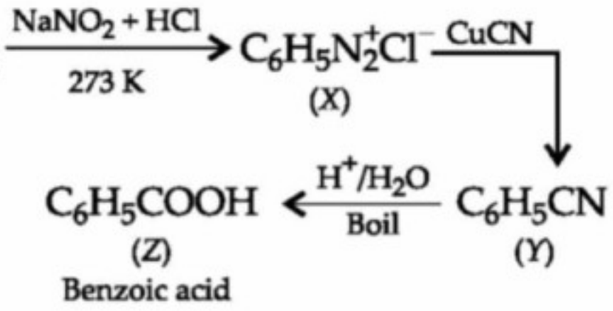
$Mg + 2HCl \longrightarrow MgCl_2 + \underset{(Y)}{H_2\uparrow}$

14. (a) : Allylic carbocation is more stable and C—H bond is easily broken as compared to C—D bond. Hence, the order is I > III > IV >II.

15. (b) :



16. (c) :



17. (a) : Structure (X) is of sucrose, a disaccharide which is a non-reducing sugar. Thus, it does not react with Tollens' reagent whereas (Y) is maltose, a reducing sugar.

18. (a) : Amoxicillin (an antibiotic) is semi-synthetic modification of penicillin.

19. (c) : Given

$N_{2(g)} \longrightarrow 2N_{(g)}$; $\Delta H^\circ = 941.3$ kJ mol^{-1} ...(i)

$H_{2(g)} \longrightarrow 2H_{(g)}$; $\Delta H^\circ = 436.0$ kJ mol^{-1} ...(ii)

$\frac{1}{2}N_{2(g)} + \frac{3}{2}H_{2(g)} \longrightarrow NH_{3(g)}$;

$\Delta_f H^\circ = -46.0$ kJ mol^{-1}....(iii)

Multiplying eqn. (i) by 1/2 and (ii) by 3/2 and then adding, we get

$\frac{1}{2}N_{2(g)} + \frac{3}{2}H_{2(g)} \longrightarrow N_{(g)} + 3H_{(g)}$ ...(iv)

$\Delta H^\circ = 941.3 \times \frac{1}{2} + 436.0 \times \frac{3}{2}$

$= 470.65 + 654 = 1124.65$ kJ mol^{-1}

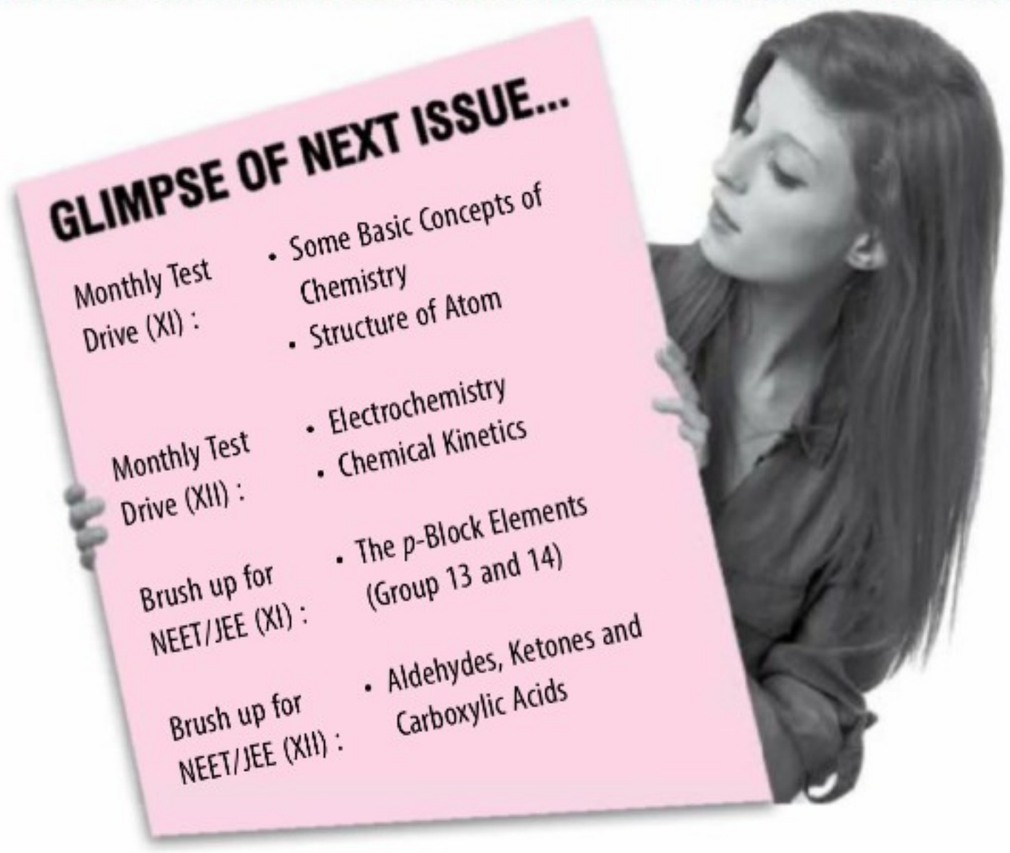
On subtracting eqn (iii) from eqn. (iv), we get

$NH_3 \longrightarrow N_{(g)} + 3H_{(g)}$; ...(v)

$\Delta H^\circ = 1124.65 - (-46.0)$ kJ $mol^{-1} = 1170.65$ kJ mol^{-1}

Since there are three N—H bonds in NH_3, the average bond enthalpy is obtained by dividing the value of ΔH° of eqn. (v) by 3.

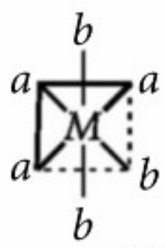
$$\text{Hence, } \Delta H_{N-H} = \frac{1170.65}{3} = 390.2 \text{ kJ mol}^{-1}$$

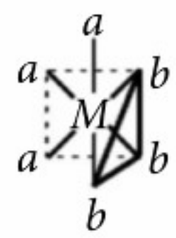


20. (a) : In octahedral complex $[Ma_3b_3]$

Facial (*fac*) **:** 3 donor atoms of same ligands occupy adjacent positions at the corners.

Meridional (*mer*) **:** When the positions are around the meridian.





21. (2) : $\rho = \dfrac{Z \times M}{a_3 \times N_0}$; $Z = \dfrac{\rho \times a^3 \times N_0}{M}$

$$= \frac{0.53 \text{ g cm}^{-3} \times (3.5 \times 10^{-8} \text{cm})^3 \times (6.023 \times 10^{23} \text{ mol}^{-1})}{6.94 \text{ g mol}^{-1}}$$

$= 1.97 \simeq 2$

22. (54) : Total time $T = n \times t_{1/2}$

or $n = \dfrac{T}{t_{1/2}}$ $\therefore$ $n_A = \dfrac{T}{54}$; $n_B = \dfrac{T}{18}$

Now for reactant A : $N_A = N_0\left(\frac{1}{2}\right)^{T/54}$

and for reactant B : $N_B = N_0\left(\frac{1}{2}\right)^{T/18}$

$$\therefore \quad \frac{N_B}{N_A} = \left(\frac{1}{2}\right)^{\frac{T}{18}-\frac{T}{54}} = \left(\frac{1}{2}\right)^{T(54-18)/54\times18} = \left(\frac{1}{2}\right)^{2T/54}$$

But $N_A = 4N_B$

$$\therefore \quad \frac{N_B}{4N_B} = \left(\frac{1}{2}\right)^{2T/54} ; \left(\frac{1}{2}\right)^2 = \left(\frac{1}{2}\right)^{2T/54}$$

$\therefore$ $2T/54 = 2$, $T = 54$ min

23. (123) : From the given data, we have,

Weight of the liquid = (148 – 50) = 98 g

Volume of the liquid = $\dfrac{98}{0.98}$ = 100 mL = Volume of vessel

The vessel of 100 mL contains ideal gas at 760 mm of Hg and 300 K.

Now weight of the gas = (50.5 – 50) = 0.5 g

Using ideal gas equation, $PV = nRT$, we get,

$$\frac{760}{760} \times \frac{100}{1000} = \frac{0.5}{M} \times 0.082 \times 300$$

$$\text{or, } M = \frac{0.5 \times 0.082 \times 300 \times 10}{1} = 123.0$$

24. (2.58) : For $2H_2O \rightleftharpoons 2H_2 + O_2$; $K_1 = 2.1 \times 10^{-13}$

For $2H_2 + O_2 \longrightarrow 2H_2O$

$$K_1' = \frac{1}{K_1} = \frac{1}{2.1\times10^{-13}} = 4.76\times10^{12};$$

Now for $H_2 + \frac{1}{2}O_2 \longrightarrow H_2O$;

$$K_1'' = \sqrt{K_1'} = \sqrt{4.76\times10^{12}} = 2.18\times10^{6} \qquad \text{...(i)}$$

$2CO_2 \rightleftharpoons 2CO + O_2$ $K_2 = 1.4 \times 10^{-12}$

For $CO_2 \longrightarrow CO + \frac{1}{2}O_2$;

$$K_2' = \sqrt{K_2} = \sqrt{1.4\times10^{-12}} = 1.1832\times10^{-6} \qquad \text{...(ii)}$$

Now adding eqn. (i) and (ii) we get

$CO_2 + H_2 \rightleftharpoons H_2O + CO$

$\therefore$ $K = K_1'' \times K_2' = 2.18 \times 10^6 \times 1.1832 \times 10^{-6} = 2.58$

25. (55.5) : $\underset{30\text{ g}}{C_2H_6} + Br_2 \longrightarrow \underset{109\text{ g}}{C_2H_5Br} + HBr$

$\underset{2\times109\text{ g}}{2C_2H_5Br} + 2Na \longrightarrow \underset{58\text{ g}}{C_4H_{10}} + 2NaBr$

55 g *n*-butane will be produced from $= \dfrac{2\times109}{58}\times55$ g ethyl bromide

As the yield is 85% , the actual ethyl bromide required

$$= \frac{2\times109}{58}\times55\times\frac{100}{85} = 243.2 \text{ g}$$

243.2 g of ethyl bromide will be produced from

$$= \frac{30}{109}\times243.2 = 66.93 \text{ g ethane}$$

As the yield is 90%, the actual ethane required

$$= \frac{100}{90}\times66.93 = 74.37 \text{ g}$$

Volume of the ethane at NTP $= \dfrac{74.37}{30}\times22.4 = 55.5$ L

COMIC CAPSULE

What do you call a tooth in a glass of water?

A one molar solution.

CHEMISTRY MUSING

SOLUTION SET 75

1. (a) : 

Before diffusion, at STP

$D_2 = 1.12\ L = 0.05\ mole = 0.2\ g$
$H_2 = 2.24\ L = 0.1\ mole = 0.2\ g$] In bulb I

When these moles are placed in the bulb, the partial pressure of gas will be different because V and T are constant. Also $P \propto n$

$$\therefore \quad \frac{P_{D_2}}{P_{H_2}} = \frac{0.05}{0.10} = \frac{1}{2}$$

Mass of D_2 left in bulb I after diffusion = 0.1 g

or, mass of D_2 diffused from I into II (bulb)

$= 0.2 - 0.1 = 0.1$ g

For diffusion of D_2 and H_2, using Graham's law

$$\frac{r_{D_2}}{r_{H_2}} = \sqrt{\left(\frac{M_{H_2}}{M_{D_2}}\right)} \times \frac{P_{D_2}}{P_{H_2}}$$

In terms of weight of gas diffused, the above equation can be written as follows :

$\because$ M g diffused gas at any P and T has volume = V

$$\therefore \quad w \text{ g diffused gas at any } P \text{ and } T \text{ has volume } = \frac{Vw}{M}$$

$$\therefore \quad \frac{V \times w_{D_2}}{M_{D_2} \times t_{D_2}} \times \frac{M_{H_2} \times t_{H_2}}{V \times w_{H_2}} = \sqrt{\frac{M_{H_2}}{M_{D_2}}} \times \frac{P_{D_2}}{P_{H_2}}$$

$$\text{or,} \quad \frac{w_{D_2}}{t_{D_2}} \times \frac{t_{H_2}}{w_{H_2}} = \sqrt{\frac{M_{H_2}}{M_{D_2}}} \times \frac{M_{D_2}}{M_{H_2}} \times \frac{P_{D_2}}{P_{H_2}}$$

$$= \sqrt{\frac{M_{D_2}}{M_{H_2}}} \times \frac{P_{D_2}}{P_{H_2}}$$

$$\text{or,} \quad \frac{0.1}{t} \times \frac{t}{w_{H_2}} = \sqrt{\left(\frac{4}{2}\right)} \times \frac{1}{2} \Rightarrow w_{H_2} = 0.14 \text{ g}$$

Mass of D_2 and H_2 in bulb II = Mass of D_2 + Mass of H_2

$= 0.10\ g + 0.14\ g = 0.24\ g$

$$\therefore \quad \%\ D_2 \text{ by mass } = \frac{0.10}{0.24} \times 100 = 41.66\%$$

% H_2 in bulb II = 58.33%

2. (d) : $2[\underset{\text{Base}}{Ag(NH_3)_2}]OH + \underset{\text{Acid}}{H-C\equiv C-H} \rightleftharpoons$

$$\underset{\text{Salt}}{Ag-C\equiv C-Ag} + 4NH_3 + 2H_2O$$

In this reaction, acetylene behaves as an acid.

3. (d) : For equilibrium mixture, $PV = \frac{w}{M}RT$

$$\therefore \quad M_{mixture} = \frac{wRT}{VP}$$

$\because$ $\frac{w}{V} = 0.925$ g/L, $T = 900$ K, $P = 1$ atm,

$R = 0.0821$ L atm K^{-1} mol^{-1}

$$M_{mixture} = \frac{0.925 \times 0.0821 \times 900}{1} = 68.35$$

Experimental molecular wt. of SO_3 = 68.35

Normal molecular wt. of SO_3 = 80

$\because$

$$SO_3 \rightleftharpoons SO_2 + \frac{1}{2}O_2$$

Moles before equilibrium :	1	0	0
Moles at equilibrium	(1 - α)	α	α/2

Where α is degree of dissociation.

$\frac{1}{\text{Normal molecular wt.}} \propto$ No. of particles before dissociation, *i.e.*, 1

$\frac{1}{\text{Apparent molecular wt.}} \propto$ No. of particles after dissociation, *i.e.*, 1 + (α/2)

$$\frac{\text{Normal molecular wt.}}{\text{Apparent molecular wt.}} = 1 + \frac{\alpha}{2}$$

$$\therefore \quad 1 + \frac{\alpha}{2} = \frac{80}{68.35}$$

α = 0.3408 or 34.08%

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Set - 75

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- Karthik B, Kerala
- Shailaja Tekaday, Maharashtra

4. (a) : $\frac{dx(1+bx)}{(a-x)} = Kdt \; ; \; dx\frac{[1-b(a-x)+ab]}{(a-x)} = Kdt$

$$\int \frac{1+ab}{(a-x)}dx - \int bdx = K\int dt$$

$-(1 + ab) \log(a - x) - bx = Kt + C$

At $t = 0, x = 0$

$-(1 + ab) \log a = C$

$\therefore \quad -(1 + ab) \log(a - x) - bx = Kt - (1 + ab) \log a$

$$Kt = (1+ab)\log\frac{a}{(a-x)} - bx$$

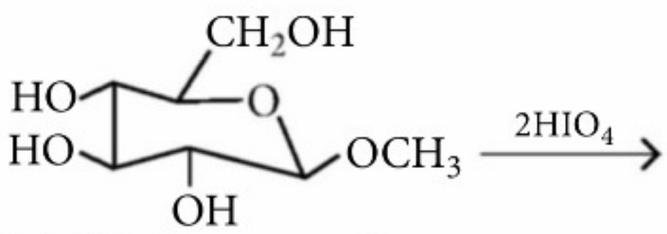
At $t = t_{1/2}, \; x = \frac{a}{2}$

$$\therefore \quad Kt_{1/2} = (1+ab)\log\frac{a}{a-(a/2)} - \frac{b\cdot a}{2}$$

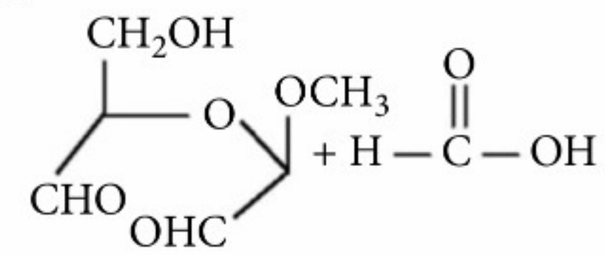
$$= (1+ab)\log 2 - \frac{b\cdot a}{2} = \log 2 + ab \log 2 - ba \times 0.5$$

$$\therefore \quad t_{1/2} = \frac{\log 2 + ab(\log 2 - 0.5)}{K}$$

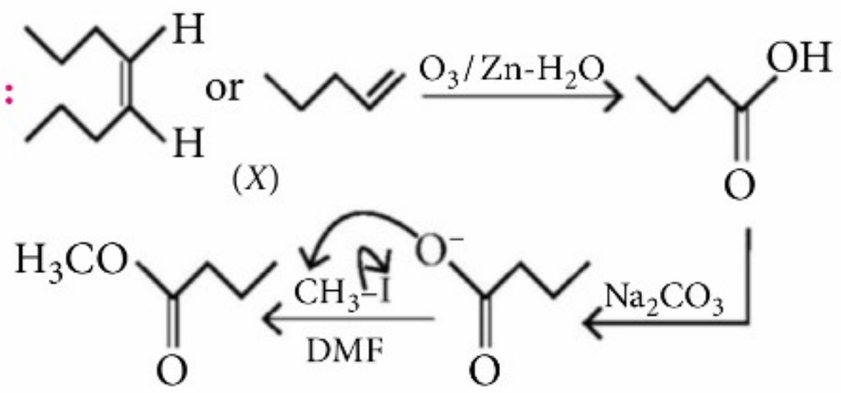
5. (a) :



Methyl-*D*-Glucopyranoside



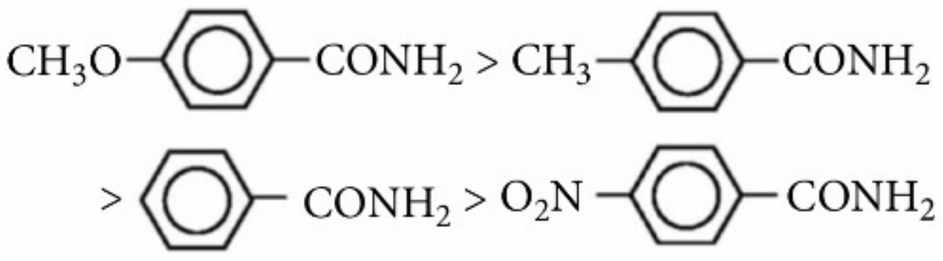
6. (a,b) :



7. (a) : During migration "*R*" does not change its configuration.

8. (c) : The rate of Hofmann bromamide reaction increases when the migrating group is electron donating and decreases when the migrating group is electron withdrawing.

Rate of reaction decreases as



9. (52.7) : Energy absorbed/photon = $\frac{hc}{\lambda_{absorbed}}$

Let n_1 photons are absorbed, therefore,

Total energy absorbed = $\frac{n_1 hc}{\lambda_{absorbed}}$

Energy emitted/photon = $\frac{hc}{\lambda_{emitted}}$

Let n_2 photons are re-emitted then,

Total energy re-emitted = $\frac{n_2 hc}{\lambda_{emitted}}$

$$E_{absorbed} \times \frac{47}{100} = E_{re\text{-}emitted}$$

$$\frac{hc}{\lambda_{absorbed}} \times n_1 \times \frac{47}{100} = n_2 \times \frac{hc}{\lambda_{emitted}}$$

$$\therefore \quad \frac{n_2}{n_1} = \frac{47}{100} \times \frac{\lambda_{emitted}}{\lambda_{absorbed}}$$

$$\therefore \quad \frac{n_2}{n_1} = \frac{47}{100} \times \frac{5080}{4530} = 0.527 = 52.7 \times 10^{-2}$$

$\because \quad x \times 10^{-2} = 52.7 \times 10^{-2}$

Therefore, $x = 52.7$

10. (68.97) : Weight of $C_2H_5OH + CH_3CHO = 0.535$ g

Let a g C_2H_5OH and b g CH_3CHO be present in the mixture, hence $a + b = 0.535$

Now mixture reacts with Fehling's solution to give a red precipitate, which suggests a characteristic reaction for aldehyde, *i.e.*,

$$CH_3CHO + 2Cu^{2+} + 5\bar{O}H \longrightarrow CH_3COO^- + \underset{\text{Red ppt.}}{Cu_2O} + 3H_2O$$

$\because \quad$ 143.08 g Cu_2O is given by 44 g CH_3CHO

$\therefore \quad$ 1.2 g Cu_2O is given by

$$\frac{44\times 1.2}{143.08} = 0.369 \text{ g } CH_3CHO$$

$\therefore \quad b = 0.369$ g

$$\therefore \quad \%\text{ of } CH_3CHO = \frac{0.369}{0.535}\times 100 = 68.97\%$$

Monthly Test Drive CLASS XII ANSWER KEY

1. (a)	**2.** (d)	**3.** (c)	**4.** (a)	**5.** (a)
6. (b)	**7.** (a)	**8.** (a)	**9.** (a)	**10.** (b)
11. (c)	**12.** (c)	**13.** (a)	**14.** (b)	**15.** (d)
16. (a)	**17.** (c)	**18.** (a)	**19.** (d)	**20.** (a,c)
21. (a,d)	**22.** (b,c)	**23.** (b,d)	**24.** (390.28)	
25. (50)	**26.** (–11.6)	**27.** (d)	**28.** (b)	**29.** (a)
30. (c)				

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